ESSAY

ON

THE CHEMICAL HISTORY

AND

MEDICAL TREATMENT

OF

CALCULOUS DISORDERS.

BY

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1817.

TO

WILLIAM HYDE WOLLASTON,

M.D. F.R.S., &c. &c. &c.

My dear Sir,

The Chemical History of the Bodies which form the subject of the following Essay, being little more than a sketch of your own discoveries, in a department of science in which our knowledge was previously exceedingly imperfect; and many of the remarks which it contains having been derived, either from your writings, or from your conversation, it is natural that I should wish my work to appear under your auspices. While justice required an acknowledgement of the source from which my information

had been principally obtained, feelings of another description urged me still more strongly to connect your name with this attempt to diffuse useful knowledge. And if I have ventured to do this without formally asking your consent, it is because I entertained some doubts whether you might not have scrupled to patronise a work in which your name occurs in almost every page. I must therefore entreat you to receive with kindness this public testimony of my esteem and regard, and believe me ever,

My dear Sir,

Your obliged and faithful friend,

ALEXANDER MARCET.

Russel Square,
Sept. 11. 1817.

INTRODUCTION.

In submitting this Tract to the medical profession, I cannot refrain from expressing my regret that so considerable a time should have elapsed since it was first announced to the public. Conscious, however, of the many imperfections of the work, I cannot with propriety plead the difficulty of the task as an excuse for the delay. For though I am not without hope that the time which has elapsed, since my intention of publishing this Essay was first made known, has afforded me the means of rendering it less imperfect; yet in reality, it was by circumstances of a private nature, and which could not have been anticipated, that the delay was occasioned.

The object of the work may be stated in a very few words. It is to describe, and

illustrate by means of accurate engravings, the characters by which the different calculi may be distinguished; to indicate the easiest analytical methods by which their chemical nature may be ascertained; and to point out the modes of medical treatment which afford the best prospect of success.

Our expectation of success, however, must be confined within certain limits. It can be entertained only in particular states or periods of the disease. Rarely, if ever, can a plan of treatment, however skilfully conducted, produce any but palliative effects, if the calculus has acquired such a size as to render the operation advisable. Lithotomy, in this case, affords the only prospect of cure. But if the progress of the disease may be arrested in its earlier stages, and if the pain and danger of a formidable operation can be averted *; or if, after the

* There is reason to believe, as will be seen in the course of this work, that the average proportion of deaths, from the operation, is no less than one in five; and that the proportion of calculous cases, admitted into our hospitals, is one for each three or four hundred cases of all descriptions.

operation, the tendency to a relapse may be effectually checked, enough, no doubt,

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The number of women attacked by this disease, so as to require an operation, is, for obvious reasons, comparatively very small. Indeed there is now every reason to hope that the female sex may in future be totally exempt from that operation. The remarkable degree to which the urethra in females is capable of being dilated, by well known mechanical means, renders it practicable in every instance to extract from their bladder, without the assistance of the knife, any calculus of moderate size; and even stones of a very considerable bulk have in a few instances, been extracted in that manner. This method of cure was proposed and actually practised by Dr. Wallis, and by Dr. Molineux, as far back as the years 1685 and 1692 (Phil. Trans. vols. xv. and xvii). But it seems to have been since lost sight of, and it was of late years revived with great success by Mr. Thomas, and Mr. Astley Cooper, as will be seen by consulting vol. i. of the Medico-Chir. Trans., and the 2d part of vol. viii., which is now in the press. In the same periodical work, vol. vi., there is a paper by Dr. Yelloly, containing a striking case of this kind, and pre-...ing a detailed view of all that had been done before ...ject.

cannot refrain, whilst upon the topic of mechanical extraction, from noticing the very singular case which occurred in India some years ago, and was lately related by Dr. Scott, then of Bombay, now of London, in the Journal of the Royal Institution ('*Journal of Science and the Arts*,' vol. i. page 199). A gentleman (Colonel Martin, then residing at Lucknow) who was

will be gained to entitle the subject to our most serious attention.

How far we may hope to accomplish these objects, will be seen in the following pages. I am well aware of the difficulty which occurs in endeavouring to apply chemical reasoning to the changes which take place in living organs, and I have not attempted to conceal it when it has appeared unsurmountable. Some collateral topics have occasionally been introduced, which, though not necessarily belonging to the subject of urinary calculi, were too much connected with it to be passed over

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labouring under calculus of the bladder, and was an ingenious mechanic, contrived to introduce into his bladder by the urethra, through a canula, a delicate saw or file made of the steel spring of a watch. With [illegible] instrument he daily succeeded in dividing and [illegible] some portion of the calculus, which was disc[illegible] the form of powder along with the urine, till at last [illegible] perfectly succeeded in removing the whole of the stone. It is impossible to learn this well authenticated fact, without heartily wishing that so harmless a method of cure, however difficult the success may appear, should be properly and zealously investigated.

in silence. I have thought it right, for instance, before describing the different species of urinary calculi, to point out the situations in which they are found, the organic changes which they produce, and the symptoms to which they give rise; and a chapter has also been introduced, for the sake of elucidation and comparison, on various species of calculi, not belonging to the urinary passages.

It was in delivering chemical lectures at Guy's Hospital, in which I had occasion to introduce the subject of urinary calculi, that I perceived how perfectly novel the chemical history of these bodies was to the great mass of students, and how anxious they appeared to avail themselves of the information, however imperfect, contained in the few lectures which I delivered on the subject. The practical utility of the pursuit, great facility with which these bodies may now be analyzed and discriminated from each other, even by persons unaccustomed to chemical manipulations, and the remarkable simplicity which modern chemistry has introduced in the history of

calculi, compared to the singular scantiness of information which prevailed in this respect twenty or thirty years ago*, are circumstances which can hardly fail to interest those who may enquire into the subject, and which I hope will secure to this Essay an indulgent reception.

This tract can scarcely be viewed, even by those who wish to preserve with the strictest rigour the artificial line by which the different departments of the profession are circumscribed, as an encroachment on the province of surgery. Indeed such is the unavoidable and constant dependence

* It will appear scarcely credible that, so recently as the year 1792, Mr. LANE, F.R.S., published, in a letter to Dr. PITCAIRN, an account of some experiments on the stone, in which the method of analyzing consisted in exposing known weights of different calculi to heat of a furnace, and ascertaining the weight they lost in that operation. For this purpose, Mr. LANE took his specimens to the Assay-master of the mint, who put them into a muffle, &c. Yet the results which were procured in this way brought to light some useful facts, though not near so distinct or instructive as those which may now be obtained in two minutes by means of a candle and a blow-pipe.



AN ESSAY

ON THE

CHEMICAL HISTORY OF CALCULI,

AND ON THE

MEDICAL TREATMENT

OF

CALCULOUS DISORDERS.

CHAPTER I.

OF THE DIFFERENT SITUATIONS IN W[redacted] 'D IN THE URINARY PASS[redacted] SYMPTOMS WHICH THEY RESPECTIV[redacted]

Calculi may be formed in all the urinary passages.

THE formation of [redacted] the urinary passages [redacted] by the separation and [redacted] ertain ingredients contained [redacted] ing independent of any spe[redacted] ry organs themse[redacted] form in any of the cavi[redacted] ne has access. Thus they [redacted] met with in the kidneys, in the ureters, in the bladder, and in the urethra; and they are more disposed to appear in the one or the other of

these situations, according as the particular part may, either from its natural form, or from morbid causes, afford the most favourable circumstances for the calculous deposition.

The kidneys, from their peculiar structure, are the organs in which the formation of calculi most frequently begins. The urine, after being secreted from the emulgent vessels, is received into the infundibula, through which it slowly passes into the pelvis, or larger cavity of the kidney, and hence again into the ureters; undergoing a kind of double filtration, which is highly favourable to the detention of any undissolved calculous matter. Concretions, therefore, are not unfrequently found both in the infundibula, and in the pelvis of the kidneys. Sometimes (as may be seen in Plate I., which is taken from a preparation in the museum of Guy's Hospital) the pelvis is much enlarged, and distended by a number of calculi closely pressed against each other. These, from some accidental morbid affection of the organ, and from their rapid increase, not having been expelled with the urine in the form

of gravel, at the earliest period of the formation, have become permanently incarcerated in the pelvis, where they have gradually increased in size, and have produced the remarkable alteration of structure exemplified in this preparation. The same diseased kidney shows the mode in which calculi are also liable to form in the infundibula, the size of these cavities being gradually dilated by the growth of the stones, till they have attained considerable dimensions; and the substance of the kidney being proportionally absorbed during the process.

Sometimes also (as is represented in Plate II.*) the renal concretion appears in the form of a single mass, which has actually been moulded by the parietes of the pelvis, so as to form a complete cast of that cavity and of its immediate ramifications, gradually increasing in size, and altering the texture of the kidney in such a manner, that nothing at last remains but a kind of

* The preparation from which this drawing was taken, belongs to Mr. ABERNETHY's collection at St. Bartholomew's Hospital.

cyst, filled with the solid body which has occasioned those effects.

When such a complete alteration of structure takes place, the secretion of urine must, of course, be entirely carried on by the other kidney. This, however, in some instances, is attended with so little inconvenience as almost to escape notice; and it sometimes even happens, that both kidneys are diseased to a most remarkable extent, and yet life is preserved for a considerable time. A striking instance of this kind may be seen in the museum of Guy's Hospital. Of two kidneys, taken from the same subject, the one is enlarged to at three times its natural size, though without any stones being actually contained in it; while the other is reduced to less than one third of the natural dimensions. A large stone, apparently of lithic acid, partly covered with a thick layer of the mixed phosphats, was found in the bladder of the same individual, who must of course, from the size of the stone, and the very considerable thickening of the coats of his bladder, have lived a considerable time under this extraordinary complication of disease.

In the ureters.

Calculi are also sometimes found in the ureters, particularly in their superior part, where they expand into a kind of pouch or funnel, forming the cavity of the pelvis; and they are detained in this situation by the small diameter of the membranous tube, compared to that of its commencement. This is the case with the kidney, delineated in Plate I., which so clearly expresses the fact as to require no further explanation. In this instance the coats of the ureters were, as generally happens under these circumstances, very considerably thickened. It is not probable, from the structure and functions of the ureters, that calculi can actually be generally formed in them, when in their healthy state; yet if, from some morbid change of structure, they should present any obstacle to the passage of the urine, concretions may then no doubt take place in the duct itself; and I have indeed seen an instance in which the internal membrane of the ureters was lined with a calculous incrustation.

In the bladder.

The bladder is the most frequent seat of calculi, as might be naturally expected, not only from the circumstance that all the

urinary concretions, or their nuclei, formed in the kidneys or ureters, tend to fall into that organ; but also because a stone may be, and probably often is, originally formed in the bladder itself.

In the Plates III. and IV.* are represented two different instances of cystic calculi. In the first of these the cavity of the bladder is nearly filled by a large calculus, round which the coats of the bladder are, as usually happens under these circumstances, very much thickened; and in the other, several calculi are seen enveloped and fixed in distinct cysts or rugæ, formed in the substance of the bladder, between fasciculi of the muscular coat of that organ, and pressing against others lodged in contiguous rugæ, so as to impart to each other by collision those regular faces and angles which are often observed in such concretions.

* Both these engravings are taken from preparations made by Mr. Astley Cooper, and now deposited in the museum of St. Thomas's Hospital.

This singular disposition of calculi was noticed several years ago by Sir EVERARD HOME, with a view to account for the supposed effects of solvents in curing the stone; and he showed, in the same paper, that the diagnostic symptoms of calculi may also sometimes be prevented from appearing, by the effect of a peculiar morbid change in the prostate gland.*

A striking instance, in which some of the most frequent effects of the stone in the bladder were prevented from taking place, by a peculiarity of situation, lately came to my knowledge through the kindness of Sir GILBERT BLANE, under whose immediate observation the case occurred. A gentleman, about 72 years old, of extraordinarily indolent and sedentary habits of life, had laboured for eight or ten years under symptoms of irritation in the urinary passages, with an occasional discharge of gravel, and of mucus sometimes streaked with blood. But he never had the usual diagnostic symptoms

* Philosoph. Transact. for 1808, p. 245, 246.

of the stone, namely, sudden stoppage of urine, pain in the glans penis, &c.; and he had never consented to be sounded. This gentleman lingered, in a state of progressive suffering, till December last, when he died in a convulsive fit. Upon examination the stone was found imbedded in a pouch, and so fixed in its place, that it did not interrupt the passage of urine, nor cause those irritations and sympathetic pains which a moveable body would have excited. An opportunity being afforded me of examining this huge stone, I found its weight to be 3083 grains; its shape was very irregular, and on attempting to saw it through, with a view to ascertain its structure and chemical nature, it spontaneously divided into two distinct masses of lithic acid, which had been connected and cemented together by an intervening layer of crystalline triple phosphat, one of the lithic masses being terminated by a large white mamillary protuberance, consisting of pure triple phosphat in unusually large and distinct crystals; and it was observed by Sir GILBERT, on the body being opened, that the situation of the stone in the bladder was such that the pointed or

mamillary extremity had been particularly exposed to the current of urine.

Small calculi of an oblong or spheroidal shape are also not unfrequently found in the urethra, the membrane of which, from the inflammation excited, is apt to contract round the stone, so that it sometimes happens that an operation is required for its removal. An instance of this kind is exhibited in Plate V., and this case is the more instructive, as the stone was first mistaken for a stricture, and an attempt was actually made to destroy it by the caustic. For the favour of obtaining a sketch of this preparation, I am indebted to Mr. ABERNETHY, in whose collection it is preserved at St. Bartholomew's Hospital. In the urethra.

Concretions of a peculiar kind are also liable to form in the prostate gland. These are usually numerous and small, seldom exceeding the size of a pea, and the enlarged prostate sometimes forms on each side of the urethra a kind of cyst, in which the calculi are found collected. This is illustrated in Plate IX. fig. 1., in which the In the prostate gland.

diseased prostate is seen laid open with the urethra passing between its lobes; and in its right lateral lobe is seen a cyst containing a number of small reddish-brown calculi. The thickened, and otherwise much diseased bladder is also exposed to view. This preparation was taken from the body of a man who died a few years ago under my care at Guy's Hospital, and whose remarkable case will be more than once alluded to in these pages. This unfortunate individual, besides this congeries of calculi in the prostate, presented an instance of the most severe calculous disorders of the urinary passages that can be met with, a coincidence which is not uncommon, though calculi of the prostate are occasionally found where there did not exist any disease in other parts of the urinary organs.

The form of disease in the prostate just described, is not however the most frequent occurrence: more commonly the calculi are imbedded in the thickened substance of the prostate, as is represented in Plate IX., fig 2., where a portion of a diseased prostate

is seen with a great number of calculi attached to it, each of which is enclosed in a cell of a membranous substance, so that the calculi are not in contact with each other. I am likewise indebted for this sketch to Mr. ABERNETHY, who allowed me to have it taken from one of his preparations at St. Bartholomew's Hospital. *

I shall now briefly relate the symptoms which the presence of calculi occasion. Symptoms of the stone.

When a calculus is lodged in the kidney, and when, from the progressive increase of the stone, a suppuration and gradual wasting of the organ takes place, the disease is generally accompanied by long-continued pain in the region of the kidney, and by a discharge of purulent urine, not unfrequently attended with copious hæmorrhage. Yet cases of this kind occur in In the kidneys.

* This is the same preparation from which Dr. WOLLASTON was supplied with the calculi which he analysed 20 years ago, when he ascertained the nature of this species of concretions.

which these symptoms are scarcely perceptible; it will appear hardly credible, for instance, that the patient from whom the kidney represented in Plate I. was taken, died of hydrothorax at Guy's Hospital, without any symptom having occurred which could lead me to suppose that there was any disease in the urinary organs.

It is probably during the passage of a calculus from the kidneys to the bladder, rather than during its formation, that the greatest pain is experienced. In the latter case the pain felt in the lumbar region is rather of the obtuse kind, whilst during the descent of a calculus into the bladder, it is sometimes most pungent, and is very apt to shoot downwards, in the direction of the ureters. In either case the disease is frequently attended with a drawing up of the testicle, and a sense of numbness in the thigh on the affected side. The urine is generally of a deep red colour; it is voided frequently and in small quantity at a time, and it often deposites a brick-coloured sediment. In many instances, as I have just observed, the passage of the stone through

the ureter, or urethra, occasions the most acute pain, with copious hæmorrhage; yet at other times a calculus is discharged without the least pain, and even without the patient being aware of its passage. A thick ropy mucus is commonly voided with the urine, or sometimes, though clear when first voided, the urine soon deposits a quantity of the mucous or puriform substance, which is often tinged with blood, and remains adhering to the vessel when the urine is poured off; and the red particles which were diffused through the urine when first voided, gradually attach themselves to the mucus, the supernatant fluid remaining nearly colourless.

These are the symptoms generally produced by calculi in the kidneys, or by their passage into the bladder; yet their occurrence, whether in succession or simultaneously, cannot be considered as an absolute demonstration of the existence of this disease, unless calculi have been actually discharged, since it is well ascertained, that symptoms very nearly similar are also sometimes occasioned by mere inflamma-

tion of the kidneys, without any concretion being present.

In the bladder.

The symptoms which indicate the presence of a stone in the bladder, are in general sufficiently distinct. An uneasy sensation is felt at the extremity of the penis, which often amounts to actual pain; but this is only perceived (at least during the first period of the disorder) on making some violent effort, or from a sudden change of posture, or immediately after expelling the last drops of urine. The pain however gradually becomes more constant, and more severe; the desire to pass urine becomes more and more frequent, and it can at last be discharged but in small quantities at a time, or even drop by drop. It often happens that the urine, when flowing in a full stream, and without any pain, suddenly stops, even when a considerable quantity of it remains in the bladder, and when, consequently, the desire of voiding it is still urgent. But it is also frequently observed, that the pain and difficulty are not felt until only a few drops of urine remain in the bladder, when this organ being no longer

defended by the interposed fluid, the pressure of the stone is much more severely felt. This pain and sudden interruption are considered by Sir JAMES EARLE as almost certain diagnostics of the disease. They are usually occasioned by the weight of the stone pressing against the neck of the bladder; the pressure, therefore, naturally made by the patient seldom answers any useful purpose. Nothing in fact can remove the obstacle but an alteration in the situation of the stone; and this is more readily effected by the patient changing the posture of his body, so as to prevent the stone from gravitating towards the neck of the bladder, than by any pressure the patient may make with a view to expel its contents. Some instances indeed are recorded, in which, the stone having acquired an enormous size, the patients, in order to evacuate their urine, were literally obliged to stand on their head, almost in a vertical position.* When, however, calculi are im-

* See in particular a case related by Sir JAMES EARLE, in the Philos. Trans. for 1809.

bedded in the folds of the bladder (as we observed above in reference to Plate IV.), they produce comparatively but little inconvenience, and may even for some time remain unnoticed by the patient himself. I must not omit to mention, in addition to this description of symptoms, that the tentency to form calculi, in whatever part of the urinary passages, is generally attended with indications of a deranged digestion, especially with acidity and flatulence, and sometimes with a distressing degree of irritation in the stomach.

Great as the evils I have just described must be, the constitution often bears them for a considerable time with a remarkable degree of impunity. The constant irritation, however, thus kept up in the urinary passages, at last produces a thickening of their coats and alters their structure; and this irritation being communicated to the neighbouring parts, a tenesmus often occurs, which adds not a little to the patient's torture, especially as all these symptoms are much exasperated by exercise, such, in particular, as riding on horseback, or in a rough car-

riage. By a long continuance of the irritation and pain, and of disturbed rest, the patient's health now becomes materially impaired; and unless the stone be soon removed by operation, the bladder becomes more and more extensively diseased, the weakness and irritability of the stomach increase to a most distressing degree, and death at last closes this long scene of suffering.

After death, the bladder is generally found more or less altered in its structure. Sometimes it is only thickened and greatly reduced in its capacity, as is illustrated in the preparation represented in Plate III.; but often also its mucous coat is most extensively diseased. A striking case of this kind is exhibited in Plate IX., to which I have already had occasion to refer; and another singular instance of diseased structure is represented in Plate IV., to which I have also before alluded, when describing a peculiar form of calculous disorders.

The presence of a stone in the urethra, though its effects may in some cases be — In the urethra.

mistaken at first for those of a stricture, is soon unequivocally indicated by a partial, or sometimes a total suppression of urine, by severe pain in the particular spot in which the calculus is lodged, and by subsequent inflammation and tumefaction of the part. A distinct instance of this form of the disease will be found in Plate V.

In the prostate gland.

When a stone is lodged in the prostate gland, and has arrived at a certain size, there is commonly some difficulty of voiding urine, and a sense of uneasiness about the neck of the bladder. But experience has shown that concretions can exist in the prostate gland without producing any great inconvenience, and sometimes even without their existence being suspected. A decisive diagnostic, therefore, of the presence of stones in the prostate, is still wanting. Some practitioners consider the circumstance of the uneasiness being much increased by riding in a carriage or on horseback as the best discriminating symptom of a diseased prostate; but similar symptoms being often occasioned by a stone in the bladder, they cannot, alone, lead to any positive conclu-

sion. But I have heard of an instance, under the observation of Mr. ASTLEY COOPER, in which this pathological point was clearly decided by manual examination. A gentleman, about 21 years of age, became subject to a suppression of urine, for which Mr. COOPER was consulted. Upon passing a catheter, a grating sensation was felt at the neck of the bladder, and the finger being introduced into the rectum, some calculi could be felt moving in a cyst within the prostate, and a distinct clashing could be heard as their surfaces were pressed together. It was proposed that a small incision should be made through the rectum into the prostate, for the purpose of extracting the calculi, but the gentleman would not consent to the operation.*

In women, the symptoms produced by Symptoms in women.

* This gentleman died a few years afterwards, when the prostate was found to contain a number of calculi, and this was also the case with his kidneys, as I shall hereafter have occasion to relate. Preparations were made from the diseased parts, which are in the collection of GEORGE VAUX, Esq. Surgeon in London, who favoured me with a sight of them.

calculi in the urinary passages are nearly the same. But from the different structure of the parts, and particularly the much less extensive course of the urethra, any small concretion, whether fallen from the kidney into the bladder, or formed in the bladder itself, is much more readily evacuated; and therefore, the formation of large stones in the bladder, and the necessity of an operation, are much less frequent in the female sex than they are in the male. Indeed from the facility with which calculi of considerable dimensions have lately been extracted from the female urethra by mere dilatation of the passage, it may reasonably be expected that the operation of lithotomy, in females, will now in every instance be superseded by that mode of extraction, which is almost exempt from pain and perfectly free from danger.

The foregoing outline of the symptoms occasioned by urinary calculi, though not necessarily belonging to my subject, will not, I trust, appear out of place in this Essay. But it may be proper to observe, that the treatment of these disorders in hos-

pitals, as well as in private practice, being usually referred to the surgical department, I have had myself but few opportunities of watching the daily phenomena of the disease; so that in giving an account of its symptoms and progress, I have in most points followed the steps of others, whose experience has far exceeded my own in this class of disorders.

CHAP. II.

OF THE DIFFERENT PREVALENCE OF URINARY CALCULI IN VARIOUS DISTRICTS AND HOSPITALS; AND OF THE COMPARATIVE FREQUENCY OF THE DISEASE IN DIFFERENT COUNTRIES.

Object of the enquiry.

ONE of the objects which appeared to me the most worthy of investigation, when I began to turn my attention to the subject of urinary calculi, was to ascertain whether this disease prevail equally, or nearly so, in various countries, and in the different stations of life; or whether its frequency be influenced by varieties of climate or situation, or by peculiarities in our habits and occupations. It is obvious that multiplied and accurate observations on this point could hardly fail to throw some light upon the nature of this problematic disorder, and might at some future time enable us to form more rational views of its pathology and treatment. In my

enquiries on this head, however, I have met with great disappointments. It is not very surprising that distinct documents should not easily be procured out of England; but it will appear scarcely credible that in the largest hospitals of London, St. Bartholomew's, St. Thomas's, Guy's, and the London Hospital, no regular, or at least no ostensible records of the cases of lithotomy which occur in them, should be preserved; so that notwithstanding the obliging and liberal disposition of the medical officers, it is almost only from collateral circumstances, and especially from the recollection of inferior officers, that a few numerical results can be obtained.

It is with great pleasure, however, that I am enabled to mention one striking exception to this unaccountable oversight in public hospitals. The Norwich and Norfolk Infirmary, in this and several other respects, stands as a model of regularity and good management. All the calculi which have been extracted by operation in that hospital for the last 44 years, amounting to 506, have been carefully preserved, with the circumstances annexed to each stone, and the event of the operation dis-

Norwich Hospital.

tinctly recorded. This valuable collection I found perfectly accessible, the moment I mentioned my object; and it is impossible for me, while upon this subject, not to express my grateful thanks for the perfect candor and polite attention which I met with from all the medical officers of that institution, when I went to Norwich for the purpose of inspecting those interesting documents. I was not only allowed to examine the calculi and the records annexed to them, without the least restraint; but upon my requesting afterwards to have an abstract of these records sent me, I was favoured by Dr. Rigby, one of the physicians to the hospital, with a complete and most satisfactory account of all the particulars in question. I was thus enabled to draw results from a larger scale of observations than was perhaps ever furnished by any single collection, and to present a point of comparison to which other records of the same kind may in future be referred.* These results, the

* I cannot refrain from observing how desirable it would be that surgeons should never inclose in sealed bottles the calculi they wish to preserve in their collec-

details of which would perhaps appear superfluous, I have thrown into a tabular form, in the following manner:

RETURNS *of the* CASES *of* LITHOTOMY *in the* NORFOLK *and* NORWICH HOSPITAL, *from* 1772 *to* 1816; *making a period of* 44 *years.*

	Number of Operations.			Deaths.		
	Children under 14.	Adults.	Total.	Children.	Adults.	Total.
Males......	227	251	478	12	56	68
Females...	8	20	28	1	1	2
	235	271	506	13	57	70

It appears from the above table that the mean annual number of cases of lithotomy in the Norwich Hospital, during the

tions, without having had their chemical nature previously ascertained. Indeed, in order to render these preparations instructive or useful, every calculus should be sawed through its centre into two portions, in order to bring into view the internal layers, and to give an opportunity of examining their chemical composition. Any small fragment detached from one of these portions, or merely the sawings of the calculus, will, in almost every instance, be sufficient for chemical examination;

last forty-four years, has been 11½, or 23 in every two years; and that the total number of fatal cases, in the 506 operations, is 70, a proportion of deaths corresponding to 1 in 7¼, or 4 in 29. It appears also that the proportion of females undergoing the operation, is to that of males, as 58 to 1000, or about 1 to 17; and that the mortality from the operation in children is only about 1 in 18; while in adults, it is 4 in 19, that is nearly quadruple.

With regard to the comparative prevalence of the disorder, at different periods, in the same infirmary, the fluctuations which have taken place in this respect do not

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and while the remaining half will afford a much more instructive preparation than the calculus in its entire state, the portion encroached upon will still furnish an useful duplicate. I may be allowed to suggest also, that it is highly desirable for the sake of public good, and for the advancement of science, that small private collections should, as much as possible, be connected with larger ones, particularly with those belonging to public institutions; since it must be admitted that it is only by viewing the subject on a larger scale, that any rational inferences may be drawn, as to the pathology and treatment of this obscure disorder.

afford any decisive result, though they would seem at first sight to indicate a tendency to increase, during the last period, as will appear from the following statement:

The number of cases of lithotomy, in the Norwich Hospital, were,

From the year 1772 to 1782......100.
——————1782 to 1792......120.
——————1792 to 1802......116.
——————1802 to 1812......137.

But, as during those respective periods, the number of admissions, as will be presently seen, suffered fluctuations, which nearly corresponded with those observed in the frequency of the stone, we are scarcely authorised to ascribe these differences to a real increase of the disorder.

With regard to the prevalence of calculous complaints in the Norwich Infirmary, in proportion to other disorders, in order that the above particulars may be compared, in that respect, with any other document of the kind, it will be sufficient to state that the total number of patients of all

descriptions, admitted into the Norwich Infirmary, during the period in question, that is from 1772 to 1816, amounted to 18,859, making an average of 428, annual admissions.* It is proper to observe, at the same time, that the number of admissions in the Norwich Infirmary has gradually, but more particularly of late years, increased by almost one-fifth; the average, within the last 8 or 10 years, having amounted to about 530, while in the 10 preceding years, it did not exceed 440.

Upon the whole, however, it certainly appears that the proportion of 506 operations of lithotomy, in the Norwich Hospital, out of 18,859 patients, which corresponds to about 1 in 38, exceeds, in an astonishing degree, that obtained from any of the other public institutions, to the records of which I have had access; and it becomes an object

* The usual number of patients in the Norwich Hospital is from eighty to ninety. The out-patients are entirely omitted in this computation, as it is evident that it is only amongst the in-patients that the operation of lithotomy is performed.

of considerable interest, for future enquirers to ascertain, by multiplied comparisons and and observations of this kind, whether this circumstance may be traced to any peculiarities in the habits or situation of that district. *

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* The number of stone cases, in different hospitals, may no doubt be in some degree influenced by the particular bias of the surgeons, or by the celebrity which they may have acquired in that operation, in consequence of which patients come from a great distance for the purpose of being operated upon. But this circumstance cannot possibly account for so great a prevalence of stone cases as that observed in the Norwich Infirmary.

In Dr. DOBSON's 'Commentary on fixed Air,' published in 1779, I find a curious statistical enquiry into the different frequency of the stone in various parts of England, from which it appears amongst other singular results, that the proportion of calculous cases, in the Norwich Infirmary, up to that period, was about 30 times as great as in the Cambridge Hospital. On the other hand, he found the disease, in other parts of England, remarkably uniform in its frequency. Thus in the Gloucester, Worcester, Hereford, and Exeter Hospitals, the proportion of stone cases, was 1 in 394 patients. In the North-east part of England, including the hospitals of Newcastle, York, Leeds, and Manchester, the proportion was 1 in 420. But in the north-west part of England, comprehending the hospitals of Liverpool, Chester, Shrewsbury, and the whole of North Wales, the proportion was only 1 in 3228. Dr. DOBSON there-

I have only farther to remark, upon this interesting document, that it does not appear, from the particulars which are annexed to it, that any of the distinguished surgeons, who have succeeded each other for the last forty years in the Norwich Infirmary, has been marked by any notable pre-eminence of success in that operation. They have probably all been more successful than the average practice of lithotomy would be found to be: but a singular degree of uniformity has hitherto prevailed in their respective results; and it is remarkable that one of these gentlemen, who operated 47 times in succession without losing a single patient, has upon the whole met with the same average number of losses as his colleagues.

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fore concluded that the stone is a more common disease in the cyder districts, than in North Wales and the north of England; and he was also led to believe from the results of his enquiry, that hard waters rather prevent than promote the formation of the stone, an opinion which seems to be confirmed by the good effects of the Buxton, Matlock, Bath, Bristol, and other hard waters, in calculous disorders.

Next to the records of the Norwich Hospital, the most distinct information of this kind which I have met with, are those published by CHESSELDEN in his 'Anatomy of the Human Body.' This celebrated surgeon states that, during the course of his public practice in St. Thomas's Hospital, a period of about 20 years *, he performed the operation of the stone 213 times, and lost only 20 patients, that is about 2 in 21, which is certainly much less than the common average. He relates some particulars respecting the ages of his calculous patients, but makes no distinction of sexes. Chesselden.

I have already stated that no ostensible records of the operation of lithotomy are kept in St. Thomas's Hospital; but by the kind assistance of Mr. TRAVERS, an eminent surgeon and lecturer in that hospital, I am informed that the average number of operations of lithotomy, annually performed in St. Thomas's Hospital, during the last 10 St. Thomas's Hospital.

* Mr. CHESSELDEN was elected assistant-surgeon to St. Thomas's Hospital in 1718, and resigned in 1738.

years, has been 5½, or 11 in each 2 years, the total number of in-patients admitted during the same period being 29,065, which makes 1 case of stone for each 528 patients. This proportion, therefore, (supposing the number of admissions to have remained stationary,) would only be about one half of what it was in CHESSELDEN'S time; and even at a much later period, the operation of lithotomy in that hospital appears to have been much more frequent than during the last few years, since Mr. CLINE lately informed me, that, to the best of his recollection, the average number of operations of lithotomy, annually performed in St. Thomas's Hospital, during the period he belonged to that institution, was about 10; and it is but a few years since that distinguished surgeon has resigned his office.

St. Bartholomew's Hospital.

In St. Bartholomew's Hospital, the same deficiency occurs as to the keeping of regular records on the subject of calculous patients. Through the obliging interference of Mr. LAWRENCE, however, I have obtained the following numerical statements

for the last five years, during which the average number of annual admissions was 3760.

In the year 1812, the cases of lithotomy were	-	14
- - 1813,	-	13
- - 1814,	-	17
- - 1815,	-	4
- - 1816,	-	8
Total in 5 years	-	56

Making an annual average of about 11 cases of lithotomy, or one case in each 340 patients.

In Guy's Hospital, where, in most respects, so much method and regularity prevail, and where I found my colleagues all disposed to give me every information in their power, it was not without great trouble that I obtained, even for so short a period as the last three years, some numerical information respecting the cases of lithotomy. The number of operations distinctly remembered and specified by the *sisters* or upper nurses of the wards, during that time, is only 22; but they all agree, and

Guy's Hospital.

the surgeons of the Hospital all concur in stating, that the frequency of stone cases has, during the last two or three years, fallen short of the average.* From the best information which I have been able to collect on this point, I have reason to believe that the mean number of operations of lithotomy in Guy's Hospital, during the last twenty or thirty years, has not been less than 9 or 10 annually; and as the annual number of patients admitted into the Hospital, upon an average of the last five years, is 2637 †, the proportion of calculous cases in Guy's Hospital may be considered as 1 in about 300 patients.

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* I should have been led to the same conclusion, from the large and valuable collection of urinary calculi, to which I shall have frequent opportunities of referring, formed by Mr. Lucas, senior, during his practice in Guy's Hospital, and continued by his son and successor, who has been so liberal as to deposit the whole of them in the museum of the Hospital, for the benefit of the school. A few additions have occasionally been made to that collection, and I have analysed and labelled all the calculi which it contains, according to their chemical composition.

† The number of patients usually in the house fluctuates between 360 and 400.

As to the proportion of fatal cases, I have been able to ascertain by the register of deaths, which is kept at the steward's office, that the total number of failures in the operation of lithotomy, within the last ten years, has been 15; which, if the number of operations in that time has been 100, as would result from the above estimate, would make the number of deaths as 3 to 20, a proportion which would come very near to that derived from the Norwich reports. As however this estimate can only be considered as an approximation, since I am not able to state the number of operations with strict accuracy, I should probably have altogether abstained from mentioning them, had I not feared that any appearance of reserve on the subject of an hospital in which I feel particularly concerned, might have been misconstrued.

Lithotomy less frequent in London than formerly.

Upon the whole, I think I have found in the course of this enquiry, sufficient ground to conclude, (though accurate data cannot at present be obtained,) that the occurrence of lithotomy in the London hospitals has, for some years, gradually diminished; and this may be owing partly to a real reduction in

the frequency of the stone, from some alteration in the diet or habits of the people, or from the use of appropriate medicines; and partly to the circumstance of calculous patients not resorting so exclusively, as was formerly the case, to the great London hospitals for the operation.

Frequency of the stone in children.

It has been observed, and this is strikingly illustrated by the Norwich records, that a very considerable proportion of the cases of calculi occur in children. This, however, obtains only among the poor classes. For in the higher ranks, or even in the lowest classes, provided they are well fed, the same frequency is not observed. In the Foundling Hospital, for instance, within the last twenty-seven years, during which 1151 children have been admitted, only 3 cases of stone have occurred, all of which were among children while at nurse in the country.* And, in the Military Asylum at Chelsea, which contains about 1250 children, and into which upwards of 6000 of them have already been admitted, no more than one

Foundling Hospital.

Military Asylum.

* I am obliged for these particulars to Mr. Earle, surgeon to the Foundling Hospital.

single case of stone has occurred, as I am informed by Mr. M'GREGOR, surgeon to that institution. It was in a female, and the stone was discharged without operation.

In Edinburgh, where I thought it might be interesting to make a similar enquiry respecting the comparative prevalence of calculous disorders, I was rather surprised to find, by an obliging communication of Dr. DUNCAN, junior, that the number of stone cases in the Royal Infirmary of that town, did not, upon an average of the last six years, exceed 2 each year, though the annual number of admissions is about 2000; and this hospital is the only one in Edinburgh which is open to the poor for surgical operations. Edinburgh.

On the Continent, the enquiries which I have made on this subject, though in general not productive of sufficiently explicit answers, have, however, enabled me to ascertain a few interesting facts. From Paris, in particular, I have succeeded in obtaining some distinct results. There are properly but two hospitals at Paris, which Paris.

may be considered as places of general resort for the operation of lithotomy *, though a few insulated cases occasionally occur in other infirmaries. These are the *Hopital de la Charité*, and the *Hopital des Enfans Maladès*. The total number of patients admitted annually, in the former of these institutions, is from 2500 to 2600, 6 or 700 of whom are chirurgical cases. From a statement with which M. Roux, an eminent surgeon to that hospital, has been so obliging as to favour me, it appears that the average number of cases of lithotomy annually occurring in the Hopital de la Charité, is from 10 to 12, a proportion which exceeds a little that of the London hospitals. At this hospital the calculous patients are, I believe, all adults, and the proportion of deaths from the operation is stated by M. Roux to be 1 in 5 or 6.

Hopital de la Charité.

* At Paris, as in all great towns, a certain proportion of patients come to the hospitals from some distance in the country: but owing to the numerous good provincial hospitals, the distance from which patients resort to those of Paris, does not exceed a radius of 100 or 120 miles.

At the hospital for diseased children, (Hopital des Enfans Malades,) as I learn by a document transmitted to me through the kindness of Dr. BIETT of Paris, about 3000 children of both sexes under the age of fifteen, are annually admitted, and the average number of stone cases is about 6. It is stated that there have occurred only three cases in females in the course of the last seven years; and that, during the same period, there have been only two instances of death from the operation.* Hopital des Enfans Malades.

I have also been favoured by Dr. BIETT with returns from some provincial hospitals in France, which deserve to be noticed. There is an hospital at *Clermont-Ferand*, in which about 2000 cases are annually admitted, 300 of which are chirurgical, and the proportion of men and women is about 1200 of the former to 800 of the latter. In this hospital the average number of calculous cases, of both sexes and of all ages, Clermont-Ferand.

* This would make an average of rather less than one death in twenty cases; a proportion of failures still smaller than that observed among children in the Norwich Hospital.

has, for the last twelve years, been 6 *, and the proportion of unsuccessful operations has been 1 in 6. The proportion of males and females afflicted with the stone is stated to be about 1 in 12.

Rouen. At the hospital of Rouen, as I am also informed by Dr. Biett, out of about 7300 patients of every description admitted during the last eighteen months, 12 have been operated, and 10 have recovered.

Vienna. From Vienna, where I had also an opportunity of making some enquiries, no accurate returns can be obtained. I learn, however, from most respectable authority, that the operation of lithotomy is comparatively very rare in that town. But this is to be ascribed neither to a want of good surgeons, nor probably to the disease being a particularly rare occurrence in that

* Before the Revolution the average number of stone cases in this hospital was 10. The gradual diminution of this disease since the Revolution is ascribed to the improvement which has taken place in the condition of the poorer classes, especially in regard to their diet.

country, but rather to the circumstance of the surgeons of Vienna having paid so little attention to this disease, that many of them, otherwise eminent in their profession, have actually finished their career without ever performing the operation of lithotomy. This is so true, that the celebrated lithotomist of Venice, PAGOLA, about fifteen years ago, having accidentally visited Vienna, where he was induced to remain ten or twelve years, and being desired by the Emperor to look for stone patients, and operate upon them publickly at the hospital, numbers of these were easily found, who had been overlooked by the Vienna surgeons, and were cut by PAGOLA with his usual success. From that time (my correspondent states) the stone has appeared a much more frequent occurrence, and the young surgeons of Vienna have had an opportunity of becoming somewhat more expert in that operation. Yet it has never become prevalent amongst them, and although they are now better acquainted with the disease, yet they are still inclined to discourage patients from submitting to the operation. So strongly indeed are the people of Vienna

prejudiced against it, that PAGOLA himself, during the last three or four years of his residence at Vienna, did not perform a single operation of lithotomy, though he sounded great numbers of persons actually afflicted with calculus of the bladder.

Geneva. At Geneva, in a population of 30,000 souls, lithotomy, including both public and private practice, has been performed only 13 times in the last twenty years, though good surgeons, are never wanting in that town to perform the operation when an opportunity occurs. Out of these thirteen patients seven were not strictly Genevese, though belonging to the neighbouring districts, and one was an Englishman; so that the disease would, at first sight, appear to be a rare occurrence at Geneva. But if the smallness of the Genevese population be taken into account, this proportion of calculous cases may not fall very short of that observed in other places. At Lyons, a populous town, which is not more than eighty miles distant from Geneva, the disease is stated to be rather frequent.

Such are the few results which I have hitherto been able to procure. In tropical climates the formation of urinary calculi is said to be almost unknown; and we have in confirmation of this singular and important fact, the recent statement of Dr. SCOTT, who from his long residence in India, and his well known habits of observation, may be considered as one of the best authorities that could be desired on a subject of this nature.* Tropical Climates.

In this early stage of the enquiry and until a much greater number of documents than those I have been able to collect shall have been procured, we should in vain attempt to connect the facts afforded by those reports with any systematic view of the causes of calculous disorders. But I indulge in the hope that the present essay may be the commencement of an investi- Inferences.

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* Dr. SCOTT expresses himself thus: "The formation of stone in the urinary bladder is nearly unknown between the tropics. I have indeed not met with a single instance of it, although I have known some cases where such a disease was imported, and not removed by climate."

gation, to which the results of subsequent researches on the subject will gradually be added. In the mean time, sufficient evidence has already been obtained to show, that, in some establishments, both in this and other countries, a remarkable uniformity prevails, in regard to the frequency of the disease, whilst in other instances, a great discordance is observable; and that none of the circumstances commonly suspected to influence this disorder, can satisfactorily account for this variety of results. This naturally leads to the suspicion that the tendency to form urinary calculi must arise from some general causes, independent of any of the peculiarities of food or beverage to which they have been usually ascribed; and since it appears that in hot climates, and especially between the tropics, these complaints are almost unknown, one is naturally led to connect this circumstance with the great changes in the urine known to arise from different conditions of the surface of the body, and to enquire whether, amongst other causes, there may not be some essential connexion between the state of the cutaneous functions, and the greater or less prevalence of this class of disorders.

CHAP. III.

OF THE DIFFERENT SPECIES OF URINARY CALCULI.—OF THEIR EXTERNAL CHARACTERS.—OF THEIR CHEMICAL NATURE AND CLASSIFICATION.

The usual mode of classification objectionable.

MOST writers on urinary calculi, in describing and attempting to class these bodies from their external characters, have kept in view the various parts of the urinary passages to which they were supposed to have respectively belonged. Thus we often meet with the expressions *renal*, *cystic*, or *urethral* calculi, applied to concretions, with a view to indicate that they had their origin in the kidneys, the bladder, or the urethra. This however is probably a mistaken ground of classification; for there is no obvious reason why the varieties of calculi, which are deposited from the urine, should not all be liable to appear in the different parts of the urinary passages; and indeed observation has shown this to be

actually the case. Thus the lithic calculus being the most common species, and not being so liable as some of the other kinds of concretion to break into fragments, it is found in the kidneys, after death, more frequently than any other. But I have also repeatedly observed in diseased kidneys the oxalat of lime or mulberry calculus; and I have at this moment under my care a gentleman, who has frequently, for some years past, discharged fragments of the fusible calculus or mixed phosphats, which are distinctly traced from one of the kidneys, in which they excite most acute pain and profuse hæmorrhage at the moment they detach themselves from that organ, after which they are immediately discharged from the bladder. This gentleman was cut for the stone some years ago, when a large calculus of the fusible kind was extracted from his bladder. But I can adduce still more positive evidence on this head; for there is in the collection of Guy's Hospital a calculus* which consists principally of the fusible substance, and which, from ex-

* This specimen is marked No. 19.

hibiting a perfect cast of the enlarged cavity of the kidney in which it was found, bears unquestionable evidence of having been formed in that organ. And as I am possessed of a calculus composed of cystic oxyd, (a representation of which is given in Plate VIII., fig. 3.) manifestly formed under similar circumstances, and actually taken out of the kidney after death, there can be no doubt, though Mr. BRANDE * and some other writers have entertained a different opinion, that all the varieties of calculi are liable to originate in the kidneys, a circumstance which renders the nomenclature above-mentioned evidently objectionable. Yet it is true that a calculus may sometimes be pronounced from its shape and appearance, especially if we have an opportunity of ascertaining the circumstances attending its passage, to have proceeded from the kidney, without having received any increase in the bladder; but this discrimination is often impossible, and at all events we never can tell with certainty from the examination of a stone found in the bladder, whether or

* See Philosoph. Trans. 1808, p. 237.

not it has received its first rudiments from the kidneys.

Calculi in the kidneys.

The calculi which are found in the kidneys not only differ from each other in their chemical nature, but they also admit of great variety in regard to their size, shape, and external appearance. Sometimes, as was before explained and exemplified in Plate II., a single mass of an enormous size presents itself, the successive layers of calculous matter having gradually moulded themselves upon the internal structure of the kidney, and caused the absorption of nearly the whole of its substance. At other times the concretions, though much smaller, may still exhibit the shape of the cavities in which they have been formed, as may be seen in Plate VIII., fig. 3. But most frequently these bodies are more or less rounded in their shape, such as those contained in the enlarged infundibula of the kidney represented in Plate I.; or in some instances they assume a polygonal form, commonly having three flattened sides, (as in figures 4. and 6. Plate VIII.) from their surfaces having been pressed against each

other during their growth. These are sometimes of a fawn or yellowish brown colour, sometimes grayish, their surface in either case being often remarkably smooth, as if coated with a fine varnish, or even in some instances having a degree of metallic lustre not unlike burnished copper.

With regard to the calculi found in the bladder, they also vary considerably in size, form, and other external qualities. Indeed, before the late discoveries respecting the chemical nature of these bodies, their general appearance was the only criterion by which medical men attempted to distinguish them from each other. The external characters of calculi are no doubt sometimes indicative of their chemical composition; but in most instances they do not lead to any certain chemical inferences, since, as we shall see hereafter, very dissimilar appearances are often produced by concretions of the same chemical nature; and calculi apparently similar, frequently prove very different in their chemical composition. Calculi in the bladder.

The form of the calculi found in the bladder is very various. It is however Their form.

mostly spheroidal (as in Plates VI. and VII., and in most figures of Plate VIII.), sometimes egg-shaped, but often flattened on two sides, like an almond. At other times they appear in the form of polygons with their surfaces flattened, obviously owing to close contact with other calculi, and to their being forcibly detained in their position by the folds of the bladder forming a kind of cyst around them. This is well expressed in Plate IV., already referred to*, which affords a striking illustration of the remarks published by Sir EVERARD HOME †, for the purpose of explaining how it has in some instances happened that calculi have existed in the bladder for a long time without producing the usual diagnostic symptoms.

Calculi also occasionally occur which are angular, and sometimes almost cubic; but this is a rare occurrence.‡ There is a

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* See p. 6. of this Essay.

† Philos. Trans. for 1808. Pouches or sacculi, in the coats of the bladder, containing stones and preventing their being discovered by the sound, were described by Mr. NOURSE, surgeon to St. Bartholomew's Hospital, as far back as the year 1741. See Phil. Trans. vol. xlii. p. 11.

‡ There is a large cubic mulberry calculus marked No. 4. in the Guy's collection. And Mr. ASTLEY

species of calculus which not unfrequently assumes the shape expressed in fig. 1. Plate VII., somewhat resembling that of a pear, with a circular protuberance at its broader end, apparently moulded in the neck of the bladder.

Urinary calculi admit of still greater varieties in regard to their bulk. In fact they vary from the size of a few particles of sand agglutinated together, to that of a mass almost filling the bladder.* The various intermediate sizes between a pigeon's and a duck's egg are the most common. Their size.

The colour and surface of calculi are also Their colour, and surface.

COOPER lately showed me 142 calculi, all of which he extracted from the bladder of a gentleman who underwent the operation of lithotomy and recovered. Their magnitude varies from a very small size to that of a die; but they all more or less affect the cubic form. They are smooth, and of the colour of glaziers' putty. They consist of lithic acid in a state of tolerable purity.

* In the Philos. Transact. for 1809, Sir JAMES EARLE described an enormous stone which he extracted after death from the bladder of a gentleman who had been unsuccessfully cut for it. This calculus weighed three pounds four ounces, and was of an oval shape, its long axis measuring 16 inches: it was of the fusible kind.

very various, and often afford indications of their chemical nature. When they have a brownish or fawn colour somewhat like mahogany wood *, with a smooth, though sometimes finely tuberculated surface†, they almost always consist of lithic acid. When cut open they appear to be formed of concentric layers ‡, sometimes homogeneous, sometimes alternating with other substances. The colour however cannot be considered as a certain criterion, since other kinds of calculi may often be coloured in the bladder, in a similar manner, by bloody mucus or other vitiated secretions.

When calculi are white or grayish-white, and friable, as in specimens 1. and 2., Plate VII., they always consist of earthy phosphats; this is particularly the case with the species called fusible; and when they are dark-brown or almost black, hard in their texture, and covered with tubercles or protuberances §, they are generally of the

* See Plate VI. fig. 1, 2, 3, and 4.
† See Plate VI. fig. 1.
‡ See Plate VI. fig. 2, 3, and 4.
§ See Plate VII. fig. 4.

species which has been distinguished by the name of *mulberry*, and consist of oxalat of lime, as will soon be explained.

Calculi have sometimes an uneven crystalline surface, (as in fig. 5. Plate VIII.) studded with shining transparent particles. This appearance always denotes the presence of the ammoniaco-magnesian phosphat.

In their specific gravity calculi vary between 1200 and 1900, water being 1000. Their odour, though sometimes urinous, is by no means always so; but when sawed through, they exhale a faint animal smell, which in some of them is very peculiar.

Their specific gravity.

Their odour.

But in their internal structure, and in the arrangement of the strata, calculi present varieties far more important than their external properties. We shall examine them in this point of view, when we treat of their chemical nature. And here I must again express my regret that the care which is taken in most collections to prevent these productions from being cut open, renders them almost useless; for it is only by

Their internal structure.

examining the interior of calculi, and by observing their successive, and often different depositions of calculous matter, that we can learn any thing as to the peculiarities of their composition.

Their nucleus.

The nucleus around which the laminæ are formed, generally consists of some of the usual species of calculi, particularly the lithic, the rudiments of which most frequently originate from the kidney. A distinct specimen of this kind is represented in Plate VI. fig. 2. But it sometimes happens that the nucleus is afforded from without, being accidentally introduced by the urethra, a circumstance by no means extraordinary, especially in women in whom that passage is so much less extensive than in men. Thus urinary concretions are often found to have formed round a pin, a piece of cloth, a fragment of a probe or of a sound, or even a musket ball.* The

* In all cases in which an accidental nucleus is afforded from without, the deposition round it consists most frequently, if not always, of the earthy phosphats, and especially of the fusible calculus, the cause of which will be hereafter explained.

formation of stones, however, round a lithic nucleus fallen from the kidney, is by far the most common occurrence.

The preceding remarks have been nearly confined to calculi of a homogeneous nature, or at least of no obvious difference of composition. But it frequently happens that on breaking them or sawing them through, they are found to consist of different concentric laminæ or layers, presenting in one mass, two, three, or even in a few instances, all the species of calculi which I have described. Thus we often meet with mulberry calculi, the dark coloured surface of which is partly, or sometimes entirely, covered with a white pulverulent layer of the earthy phosphats or fusible calculus. At other times we find layers of the phosphats and mulberry calculi surrounding a lithic nucleus *; and in the interesting specimen represented in fig. 8. Plate VIII., (for which I am indebted to Dr. Wollaston) all the species, namely, the fusible, the mulberry, the pure phosphat of Alternating layers.

* See Plate VII. fig. 3.

lime, and the lithic, are seen alternating with each other.

Calculi of the prostate.

The calculi to which the prostate gland is subject seldom exceed in size the largest of those represented in C D Plate IX. fig. 2.; they are of a yellowish-brown colour, and are more or less rounded in their shape, resembling in their external appearance the small lithic calculi which are so often discharged from the bladder. In their chemical composition however, they are altogether different from the lithic concretions, as will presently be explained. The occurrence of these bodies in the prostate gland is connected with various changes of structure, which will be found described in the explanation annexed to the Plate last quoted.

Chemical history of calculi.

In the foregoing sketch of the external characters of urinary calculi, I have purposely avoided entering into any particulars concerning their chemical properties, though I have alluded in general terms to their composition, with a view to point out some connexion between their external appearance and the nature of their constituents.

The remaining part of this chapter will be more particularly devoted to the history of their chemical properties.

Physicians and chemists, from GALEN to PARACELSUS, and from PARACELSUS to VAN-HELMONT and BOERHAAVE, had only showed, by their vague and often unintelligible speculations on the subject, how inadequate chemical science was, in their time, to enable them to form any rational conjectures on the composition of urinary calculi.* It is to the celebrated Swedish chemist SCHEELE, not farther back than the year 1776, that we are indebted for the first chemical observation on the subject of calculi, which has in a great degree led the way to all the subsequent discoveries on the nature of those bodies. This great chemist, at the period just mentioned, published a paper in the Transactions of Stockholm, in which he stated that all the urinary calculi which he had examined consisted of a peculiar concrete acid, (the substance which has since

Early enquirers.

Scheele.

* A good sketch of these early attempts may be found in Fourcroy's "Système de Chimie," vol. x. p. 204.

successively received the names of *lithic* and *uric acid*) which he showed to be soluble in alkaline lixivia. This, no doubt, was an important step. Yet the knowledge of this sagacious philosopher remained so imperfect on the subject, that he took it for granted that all urinary concretions consisted solely of that substance, and were all fundamentally the same; an error into which it is extremely difficult to conceive how a man of so much chemical experience and discrimination could possibly have fallen. For we shall soon see that concretions of the pure lithic kind, far from being the only species of urinary calculi, do not even constitute one-half of the concretions which are formed in those passages.

Scheele not only discovered that the lithic matter was soluble in alkali, but he also showed that it was in some degree capable of being dissolved in cold water; that this solution possessed acid properties, and in particular that of reddening litmus; that it was acted upon in a peculiar manner when boiled in nitric acid; and, lastly, that human urine always contained

this substance in greater or less quantity, and often suffered it to separate in the form of a brick-coloured sediment, by the mere effect of cooling.

These results were soon confirmed by BERGMANN, MORVEAU, and other chemists. It is, I believe, from the last-mentioned philosopher, that this substance received the name of *lithic acid*, or acid of the stone; a term which, though perhaps not strictly accurate, I have generally used in preference to that of *uric*, subsequently proposed by Dr. PEARSON, and adopted by most chemists; the latter name appearing to me objectionable, not only because the substance in question is found in gouty concretions, as well as in urine, but also on account of the close resemblance which the term *uric* bears to that of *urea*, another and most characteristic constituent of urine, totally distinct from this. Bergmann, Morveau, &c.

After the discovery of SCHEELE, FOURCROY and VAUQUELIN, in France, and in this country Dr. WOLLASTON, are the chemists who have contributed the most to bring

the natural history of urinary concretions to its present state of improvement. Dr. PEARSON *, Dr. HENRY of Manchester †, and Mr. BRANDE ‡, have also added useful facts to the history of those bodies.

If SCHEELE's discovery constitutes an important æra in the chemical history of urinary calculi, the labours of Dr. WOLLASTON, who first ascertained, twenty years afterwards, the nature of no less than four other species of human concretions §, three of which belong to the urinary organs, unquestionably deserve a most conspicuous place. It is the more desirable, that his claims in this respect should be placed in the clearest point of view, as the late celebrated M. FOURCROY, both in his 'Système des Connoissances Chimiques,' (which contains an elaborate sketch of urinary calculi)

Dr. Wollaston.

Fourcroy.

* Philos. Trans. 1798.

† Henry's Dissert. Inaugur. de Acido Urico, 1807.

‡ Philos. Trans. 1806 and 1808.

§ These were: 1st, The gouty concretions; 2d, The fusible calculus; 3d, The mulberry calculus; 4th, The calculus from the prostate gland. In the year 1810, Dr. WOLLASTON also discovered the cystic oxyd.

and in his various papers on this particular subject, has, in a most unaccountable manner, entirely overlooked Dr. WOLLASTON's labours, and in describing results exactly similar to those previously obtained and published by the English chemist, has claimed them as his own discoveries. Yet Dr. WOLLASTON's paper was printed in our Philosophical Transactions two years before FOURCROY published his Memoir in the 'Annales de Chimie,' and three years before he gave to the world his 'Systême des Connoissances Chimiques;' and he discussed in these works a paper of Dr. PEARSON on the lithic acid, published in a volume of the Philosophical Transactions *, subsequent to that which contained the account of Dr. WOLLASTON's discoveries!

It is extremely painful to be compelled by justice to notice such an apparent want of fairness and candour in a philosopher, who devoted a long and brilliant career to the advancement of science. But unless this circumstance should hereafter be satis-

* Philos. Trans. for 1798.

factorily explained, it will be impossible for posterity to overlook such an unjustifiable omission, particularly in a man whose great fame and peculiar merits as a chemical philosopher, seemed to preclude all temptation to plagiarism.*

Component parts of calculi.

The substances hitherto discovered in urinary calculi, by the labours of the philosophers above-mentioned, are as follows:

Lithic or uric acid.
Phosphat of lime.
Ammoniaco-Magnesian phosphat.
Oxalat of lime.
Cystic oxyd.

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* FOURCROY, in his various memoirs on the subject of calculi, generally associates to his name that of M. VAUQUELIN, a philosopher whose accuracy and candour are known to the whole world, and no body doubts the great share which that celebrated chemist has had in FOURCROY's experimental researches. But it is well known also, that the task of publishing the results of their common labours always devolved upon FOURCROY, and that M. VAUQUELIN being not conversant with the English language, could not easily obtain an early knowledge of English scientific publications.

To which enumeration may be added a variable proportion of animal matter, connecting and cementing the other ingredients.

It very seldom happens that these substances exist singly, and in a state of perfect purity in urinary concretions; yet some of them generally prevail in a sufficient degree to impart to the calculi a peculiar character. And when the mixture is such as to preclude the appearance of any characteristic form, I would (in compliance with Dr. HENRY's suggestion *) assume this circumstance as the distinguishing quality of an additional species of urinary concretions.

Upon the whole, therefore, the different kinds of urinary calculi may be arranged under the following heads: viz.

I. The *Lithic* Calculus. Classification.
II. The *Bone-earth* Calculus, principally consisting of phosphat of lime.
III. The *Ammoniaco-Magnesian Phosphat*,

* Henry's Elements of Chemistry, vol. ii. p. 365.

or calculus in which this triple salt obviously prevails.

IV. The *Fusible* Calculus, consisting of a mixture of the two former.

V. The *Mulberry* Calculus, or oxalat of lime.

VI. The *Cystic* Calculus, consisting of the substance called by Dr. WOLLASTON cystic oxyd.

VII. The *Alternating* Calculus, or concretion composed of two or more different species, arranged in alternate layers.

VIII. The *Compound* Calculus, the ingredients of which are so intimately mixed as not to be separable without chemical analysis.

IX. Calculus from the *Prostate* Gland. *

I shall now proceed to examine in succession the chemical properties of these different species.

Lithic calculus.

I. LITHIC CALCULUS. The substance first described by SCHEELE, under the name of lithic acid, forms a hard, inodorous con-

* It will be seen hereafter that I have met with two specimens of calculi, which do not appear to be referable to any of the species above enumerated.

cretion, of a brownish or fawn colour*, and sparingly soluble in water, from which, in cooling, it separates in small yellowish particles. † It is not much acted upon by ammonia, but is easily dissolved by solutions of either of the fixed alkalies, from which it may be precipitated, in the form of a white powder, by all the other acids, even by the carbonic. It is insoluble in either the muriatic or the sulphuric acid; but is soluble in the nitric, and the residue of this solution, when evaporated to dryness, assumes a remarkably bright pink colour, which however disappears on adding either an acid or an alkali.

Lithic acid is not acted upon either by the carbonated or sub-carbonated alkalies, and is but very sparingly soluble in lime-water. When exposed to the action of the blow-pipe it blackens, emits a peculiar animal smell, and gradually evaporates, leaving

* The appearance of this calculus, and the different forms it assumes, are represented in Plate VI. fig. 1, 2, 3, and 4., and were described in the last chapter.

† One part of lithic acid dissolves in 1720 parts of cold, and 1150 parts of boiling water. This solution is capable of reddening vegetable blue colours.

only a small quantity of white ash which is commonly alkaline. Sometimes the calculus is observed to crackle or decrepitate, and to fly into a number of fragments, when heat is applied to it, peculiarities which are apt to occur when a small portion of oxalat of lime is mixed with the lithic matter. When lithic acid is subjected to distillation, about one-fourth of its weight arises of a yellow sublimate, which contains no lithic acid; but is, according to Dr. Henry, a new and peculiar acid combined with ammonia. A few drops of a thick oil, and some carbonat of ammonia, with some prussic acid, water, and carbonic acid, next distil over, and about one-sixth of charcoal remains in the retort.

Bone-earth calculus, or phosphat of lime.

II. Phosphat of Lime. The frequent occurrence of this substance in urinary calculi had been mentioned by Bergmann, and distinctly ascertained by Dr. Pearson and other chemists. But the existence of urinary concretions, consisting entirely of phosphat of lime, and constituting a species of its own kind, was first pointed out by Dr. Wollaston, whose description of this

calculus I shall transcribe in his own* words. "Its surface is generally of a pale brown, and so smooth as to appear polished; when sawed through, it is found very regularly laminated, and the laminæ in general adhere so slightly to each other, as to separate with ease into concentric crusts. In a specimen with which I was favoured by Dr. BAILLIE, each lamina is striated in a direction perpendicular to the surface, as from an assemblage of crystalline fibres."

This calculus, when pulverised, dissolves without difficulty in the muriatic or nitric acids. When urged by the blow-pipe, it first blackens, owing to the charring of the animal matter which it contains; but it soon becomes perfectly white again, and then resists the action of the blow-pipe without any alteration, unless the heat be most intensely urged, when it may at length be fused. This susceptibility of fusion does not exist in the earth of bones, because it

* Philos. Transact. 1797. The calculus represented in Plate VIII. fig. 7., is a well characterized fragment of the identical specimen described by Dr. WOLLASTON.

contains a greater proportion of lime than the phosphat of urinary calculi.

I have only to add on this head, that calculi consisting entirely of pure phosphat of lime, or even layers exclusively formed of this substance, have appeared to me comparatively a very rare occurrence, though portions of it are so frequently met with combined with the other species of calculi; and I have no doubt, from FOURCROY's description of this calculus*, that he has often confounded it with the fusible concretion which I shall presently notice.

Triple calculus

III. THE TRIPLE CALCULUS, OR AMMONIACO-MAGNESIAN PHOSPHAT. It is again to Dr. WOLLASTON that we owe our accurate knowledge of this salt †, as a constituent part of urinary concretions. Calculous masses, consisting solely of this substance, are perhaps never met with; but concre-

* Système de Chimie, x. 226.

† Philos. Transact. 1797. FOURCROY and VAUQUELIN had, some years before, ascertained the occurrence of this calculus in the intestines of animals.

tions often occur in which it obviously prevails, and this triple salt frequently appears also in the form of minute sparkling crystals diffused over the surface, or between the interstices of other calculous laminæ. * Calculi in which this triple salt prevails are generally whiter and less compact than those of the former class. When the blowpipe is applied, an ammoniacal smell is perceived, the fragment diminishes in size, and if the heat be strongly urged, it ultimately undergoes an imperfect fusion, being reduced to the state of phosphat of magnesia.

The best mode of obtaining this substance for chemical examination, is to collect the white crystalline sand which is deposited by the urine of persons in whom the earthy phosphats are redundant, as this deposite always contains the triple calculus in a state of greater or less purity.

* A large mass of crystallized triple phosphat, attached to a lithic calculus, which occurred in a patient of Sir GILBERT BLANE, was described in the first chapter of this Essay; and the most usual form of this species of calculus is represented in Plate VIII. fig. 5.

The form of the crystals (according to Dr. WOLLASTON) is a short trilateral prism, having one angle a right angle, and the other two equal, terminated by a pyramid of 3 or 6 sides. These crystals are but very sparingly soluble in water, but very readily in most if not all the acids, and when precipitated from them, reassume the crystalline form. From the solutions of these crystals in muriatic acid, sal-ammoniac may be obtained by sublimation. Solutions of caustic alkalies disengage ammonia from the triple salt, the alkali combining with a portion of the phosphoric acid. An artificial ammoniaco-magnesian phosphat may easily be formed by synthetic means. Thus if magnesia be dissolved in phosphoric acid, and ammonia added, the crystalline triple precipitate immediately appears.

Fusible calculus.

IV. THE FUSIBLE CALCULUS. This concretion, which, with the exception of the lithic, occurs more frequently than any other species, was first ascertained to differ from the substance described by SCHEELE, by the late Mr. TENNANT, who found that, when

urged by the blow-pipe, instead of being nearly consumed, a large proportion of it melted into a white vitreous globule. Mr. TENNANT's examination was carried no farther; but Dr. WOLLASTON resumed the subject, and ascertained the chemical nature of this species of calculus, an account of which was published in the same paper to which I have already often referred. *

The fusible calculus is commonly whiter and more friable than any other species. It sometimes resembles a mass of chalk, leaving a white dust on the fingers, and separates easily into layers or laminæ, the interstices of which are often studded with sparkling crystals of the triple phosphat, as was before observed. At other times it appears in the form of a spongy and very friable whitish mass, in which the laminated structure is not obvious. † Calculi of this kind often acquire a very large size, and they are apt to mould themselves in the contracted cavity of the bladder, assuming

* Philos. Transac. 1797.

† See Plate VII. fig. 2.

the peculiar form expressed in Plate VII. fig. 1., in which the stone terminates at its broader end in a kind of peduncle, corresponding to the neck of the bladder, a peculiarity of form which I never observed in any of the other species of calculi.

With regard to the chemical composition of the fusible calculus, it has been most satisfactorily shown by Dr. WOLLASTON to be a mixture of the triple phosphat and phosphat of lime. These two salts, which, when separate, are infusible, or nearly so, when mixed together and urged by the blow-pipe, easily run into a vitreous globule; and a similar result is obtained if a quantity of triple phosphat, artificially prepared, be mixed with phosphat of lime, so as to imitate the fusible calculus.

The composition of this substance may be shown in various ways. Thus, if it be pulverised, and acetic acid poured upon it, the triple crystals will be readily dissolved, while the phosphat of lime will scarcely be acted upon; after which the muriatic acid will readily dissolve the latter phosphat,

leaving a small residue consisting of lithic acid, a portion of which is always found mixed with the fusible calculus. This portion is generally minute; but sometimes it is more considerable, and in some instances it is so much so as to give to the calculus an equivocal character.

From the acetic solution the triple crystals may be recovered, with their characteristic appearance, by the addition of carbonat of ammonia; and from the muriatic solution, the lime may be precipitated by oxalat of ammonia. As to the phosphoric acid, its presence may easily be rendered obvious, after the separation of the lime, by adding to the remaining liquor a solution of muriat of magnesia, with some carbonat of ammonia, by which means an ammoniaco-magnesian phosphat is immediately precipitated in its usual form. * The

* The presence of phosphoric acid may also be shown by reducing it to the concrete state, by the blow-pipe, on a slip of laminated platina; the acid, when thus urged, communicating to the flame a peculiar green tinge. By processes of this kind the nature of the component parts of calculi is easily ascertained; but when an exact knowledge of proportions is desired, more elaborate operations are

neutral carbonat is better adapted to produce this effect than the sub-carbonat.

As the proportions of the two phosphats in this calculus are liable to indefinite variations, so its degree of fusibility is also very different. The proportion of lithic acid may be ascertained by a solution of caustic potash, which dissolves the lithic matter, and expels the ammonia, but has no effect upon the other ingredients of the calculus.

It has already been observed that calculous concretions are exceedingly apt to form around any foreign substance which may accidentally penetrate into the urinary passages. The operation of lithotomy is not unfrequently rendered necessary by a circumstance of this kind; and (as I am informed by Sir JAMES MACGREGOR) this happened lately in the case of a soldier who received a wound at the battle of Waterloo, from a musket-ball which lodged in his bladder. He was cut for it in the usual mode, and

required, some of which are pointed out in Dr. WOLLASTON's papers in the Philos. Transactions for 1797 and 1810.

the ball was found covered with a thick incrustation which I found to be of the fusible kind.

In a great number of instances of this sort which have come to my knowledge, the concretions so formed have uniformly proved to consist of the mixed phosphats or fusible calculus. The calculous matter which is sometimes deposited between the prepuce and the glans, and in general that which is apt to form when urine is detained in the passages, are of the same nature; and the growth of these calculous incrustations is sometimes extremely rapid. This, at first sight, may appear singular; but when it is considered that urine always becomes alkaline some time after it is discharged, in consequence of the ammonia which is evolved when the process of putrefaction begins, and that this alkalescence is unavoidably attended with the precipitation of the phosphats contained in the urine, the phenomenon in question is easily explained. For when the urine is detained in the bladder, either by a mechanical obstruction, or by the irritation which the

pressure of a foreign body occasions, the process of decomposition above described necessarily takes place, with the same train of consequences.

Mulberry Calculus.

V. The Mulberry Calculus, or Oxalat of Lime. Until Dr. Wollaston analyzed the calculus thus named from its external resemblance to the mulberry, all that was known of its nature was that it was not, like the lithic acid, soluble in alkalies. Dr. Wollaston having submitted calculi of this class to chemical analysis, found them to consist of oxalat of lime, generally united with a little lithic acid and phosphat of lime. By applying a solution of caustic potash to the calculus in powder, all the lithic acid was separated. Phosphoric acid being then added, the phosphat of lime was dissolved; and the remainder, after being well washed, was decomposed by sulphuric acid, the affinity of this acid, for a portion of the lime, being superior even to that of the oxalic acid. Selenite was therefore formed, and the oxalic acid thus set at liberty was easily recognised by its mode of crystallizing and other properties.

Calculi of this species, when finely pulverised, and with the assistance of heat, are soluble in the muriatic and nitric acids. The pure alkalies do not decompose this calculus; but when it is digested with alkaline carbonats, the alkali combines with the oxalic acid, and the carbonic acid with the lime.* The presence of lime in this body is easily demonstrated by exposing it to a red heat; the oxalic acid is volatilised and destroyed, and the white residue which remains is quick-lime, as may be easily shown by the usual tests.

Though this calculus has been named *mulberry* from its external resemblance to that fruit, yet a great many concretions of this class occur, which, far from having the mulberry appearance, are remarkably smooth and pale coloured, as the specimen represented in Plate VIII. fig. 6., so as to resemble in hue, as well as smoothness, the surface of a hemp-seed.† From this cir-

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* FOURCROY, Système de Chimie, x. 229.

† This variety of calculus is probably always of renal origin; at least it has frequently been found in the

cumstance it is with plausibility conjectured that the dark colour of the tuberculated calculi, such as that delineated in Plate VII. fig. 4., may arise from blood voided in consequence of their roughness.

It may be worth while to mention that in the course of the last four years, I have met with three specimens of mulberry calculi, passed by three different persons, having a distinct crystalline texture; they were all of a pale brown colour, and the crystals of which their surface was composed, though at first sight having the appearance of mere square plates, proved, upon closer examination, to be very flat octohedrons. They were examined by Dr. Wollaston, who considered them as a curious variety hitherto undescribed. None of them exceeded the size of a pea.

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kidneys after death. It appears that persons who have voided this species of concretion are much less liable to a return of the complaint than those subject to the lithic calculus. This is an interesting remark of Mr. Brande, with which my own observation fully coincides. (Phil. Trans. for 1808, page 238.)

VI. The Cystic Oxyd. This calculus was first described by the discoverer, Dr. Wollaston, in the Philosophical Transactions for 1810. The first specimen which fell under his examination was put into his hands by the late Dr. Reeve of Norwich, soon after which he found another in the collection of Guy's Hospital.

Cystic-oxyd calculus.

In external appearance, Dr. Wollaston observes, these calculi resemble more nearly the triple phosphat of magnesia than any other sort of calculus; but they are more compact, and do not consist of distinct laminæ, but appear as one mass confusedly crystallized throughout its substance. They have a yellowish semi-transparency, and a peculiar glistening lustre, like that of a body having a high refractive density.* Under the blow-

* These appearances have been accurately expressed in Plate VIII. fig. 1. and 2., which exhibit, the one an external view, and the other an internal section of the calculus. This plate is taken from the specimen already mentioned, in the collection of Guy's Hospital; and it may be remarked in addition to the characters given by Dr. Wollaston, that there is in this specimen a kind of central nucleus, which, though of the same chemical na-

pipe, the new calculus gives a peculiarly fœtid smell, quite distinct from that of lithic acid, and at no period resembling the smell of prussic acid. Distilled in close vessels, it yields fœtid carbonat of ammonia, partly fluid and partly solid, and a heavy fœtid oil; and there remains a black spongy coal, much smaller in proportion than from lithic acid.

It is so readily acted upon by chemical re-agents, that its characters are best taken from an enumeration of the few feeble powers which it can resist. These are water, alcohol, acetic, tartaric, and citric acids, and saturated carbonat of ammonia; all which are incapable of dissolving it, except in very minute proportion.

Its solvents, on the contrary, are very numerous. It is abundantly dissolved by muriatic, nitric, sulphuric, phosphoric, and oxalic acids; by potash, soda, ammonia, and lime-water; and even by the neutral

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ture, appears denser and less crystalline in its texture than the rest of the mass, and the limit between these two parts of the calculus is distinctly defined.

carbonats of potash and soda. When, therefore, it is intended to separate it from acids, the neutral carbonat of ammonia is best adapted to the purpose, as it is not capable of re-dissolving the precipitate even when added in excess; and for the same reason the acetic and citric acids are best suited to precipitate it from alkalies.

Its combinations with acids crystallize in slender spiculæ, radiating from a centre, which readily dissolve again in water. Its compounds with alkalies form small granular crystals.

This calculus, therefore, appears to be, in common with oxyds, disposed to unite with both acids and alkalies; and the fact of its containing oxygen (though the quantity of this element is not sufficient to give the calculus acid properties), is proved by the formation of carbonic acid in distillation. Upon these grounds Dr. WOLLASTON considered this substance as an oxyd; and as, in the only two instances in which this calculus had yet occurred, under his observation, it had been taken from the bladder, Why thus named.

he gave it the name of *Cystic Oxyd.* Soon after this, Dr. HENRY found two calculi of this description in a collection in his possession; and within the last few years I have detected cystic oxyd in no less than three instances. The particulars of these cases being interesting, and illustrative of the origin of this species of calculus, I shall briefly relate them.

Instances of cystic oxyd found in the kidneys.

The first of these calculi was brought to me for examination about three years ago, by Mr. BIRKITT, a stationer in Norton-Falgate, about 30 years of age, who, conjointly with Mr. NEWINGTON, surgeon in Spital-Square, under whose care he had been, gave me the following particulars:—

About 12 years ago Mr. B. was first affected with symptoms of the stone, for which he was cut about two years afterwards by the late Mr. YOUNG, of Finsbury-Square. The calculus which he put into my hands three years ago was then extracted; it closely resembled, in external appearance, the specimen represented in Plate VIII. fig. 1. and 2., and upon further examination

proved to be exactly of the same nature. Mr. B. at the same time showed me many smaller calculi, which appeared to be all of the same chemical nature, and which he had passed by the urethra at different periods, both before and after the operation. But the most remarkable circumstance of his narrative was, that the evacuation of these stones had invariably been preceded by pain in the left kidney shooting down the ureters, and, as he thought, following the course of the stone; but he never was subject to pain at the extremity of the penis, or at the neck of the bladder. His general health was good, except as the time a calculus was descending into the bladder. He had not, since the operation, had any symptoms of stone in the bladder, the calculi being generally voided immediately on their descending from the kidneys; nor had he felt any uneasiness in the spot where he was cut, except when a calculus, however small, came into contact with it, previous to its being discharged, which occasioned a disagreeable sensation.

Having lately had occasion (in June 1817) to see Mr. B., he informed me that he had, upon the whole, continued in good health; that the fits of pain, previous to the evacuation of the calculi, which used to occur about once in six months, had become much milder; and that the hæmorrhage had ceased, though the evacuation of calculous matter, in small quantities, had occurred even more frequently than formerly, perhaps about once a month. He added that he was rather subject to be bilious or dyspeptic; but that he was never troubled with acidity.

Here, therefore, we have a distinct instance in which the cystic oxyd originated in the kidney, contrary to the supposition from which it received its name.

The next instance of cystic calculus which occurred to me was that of Mr. W. L., a gentleman about 30 years of age, who died in the course of last year, in the neighbourhood of London, with symptoms of renal calculi. His body was opened by Mr. Hammond, surgeon at Southgate, and a

number of calculi were found in the kidneys. These were put into my hands by Mr. Astley Cooper, and proved upon examination to be pure cystic oxyd. One of them, which is represented in Plate VIII. fig. 3., had moulded itself in the enlarged infundibulum in which it was found, so as to afford by its shape a permanent proof of its origin.

Having heard that an elder brother of the last-mentioned gentleman had also died, not long since, with symptoms of calculi, I applied for particulars to his surgeon Mr. Vaux, who attended him during his last illness, and from whose kindness I obtained the following particulars:—Mr. L., the gentleman in question, was between 30 and 40 years of age. He had occasionally passed small stones from his bladder with more or less inconvenience, and had laboured under disease of the prostate; but at the period of his death, he had no particular uneasiness in his bladder, nor any obvious deficiency in the secretion of urine. The only warning his medical friends had of his danger, was his being suddenly seized with a febrile

delirium, as if from some great irritating cause, and yet without any particular pain. Under this state his vital powers sunk rapidly, and he died in the course of a few days. His body was opened, and the following appearances presented themselves: — One of the kidneys was found reduced to the state of a small cyst or bag, without any distinct remains of organic structure, by which the kidney could have been recognised, except its being attached to the ureter. The other kidney was enlarged, and contained several calculi of the cystic kind, which I ascertained to be such by chemical examination, and one of which, had, as in the instance of his brother, assumed the form of the cavity of the kidney from which it was taken. No calculus was found in the bladder. The prostate was very much enlarged, and contained several calculi *, one of which I had an opportunity of examining, and I found it to be of the usual composition, namely phosphat of lime.

* This is the same case of diseased prostate to which I have already alluded, page 19. of this Essay, in describing the symptoms of the disease.

I am informed that a third brother of the gentlemen just mentioned, who died in Ireland, was also subject to calculi, one of which Mr. VAUX extracted from his urethra; but, unfortunately, this calculus cannot be with certainty identified in Mr. VAUX's collection, and I have not been able to obtain any further particulars of the case.

From the above statement, however, it appears unquestionable that in the three instances in which I have detected calculi formed of cystic oxyd, every one of these has been of renal origin, whilst there are only two instances upon record *, in which this species of calculus has been found in the bladder; and even in these, there is no evidence adduced of their not having originally fallen into the bladder from the kidneys. The name of *renal* or *nephritic oxyd* would therefore be more appropriate. But unless some great systematic object be at stake, there is so much less inconvenience

* The specimen sent to Dr. WOLLASTON, by Dr. HENRY, since the publication of Dr. W.'s paper, appears also to have been taken from the bladder.

incurred, in chemical science, by retaining a name which is not strictly accurate, than by changing appellations which have been once established, that I do not feel inclined to propose any new name for the cystic oxyd. I have only farther to observe on this substance, that all the specimens I have seen, from five different persons, have been remarkably pure and free from any other ingredients. * It would appear, therefore, that the cystic-oxyd dyathesis (if I may be allowed the expression) has a more exclusive tendency, in regard to the formation of other kinds of calculi, than the other species of urinary concretions.

Compound calculi in layers.

VII. Compound Calculi, in distinct Layers. It frequently happens, as I have already had occasion to observe, that urinary concretions are composed of different species of calculous depositions disposed in layers around a common nucleus. Thus lithic strata frequently alternate with layers

* Dr. Wollaston observes, however, that one of the two specimens he examined was covered with a loose coating of phosphat of lime.

of oxalat of lime, as in the mulberry calculus delineated in fig. 5. Plate VII.; or with the phosphats, as in the specimen represented in fig. 4. Plate VI., in which a chalky crust may be seen at the surface.* Sometimes also the mulberry alternates with the phosphats, as in fig. 3. Plate VII.; and in a few instances three, or even four species of calculi occur in the same stone disposed in distinct concentric laminæ. This is the case with the interesting specimen represented fig. 8. Plate VIII., for which I am indebted to Dr. Wollaston, and in which lithic acid may be distinctly seen in the centre, pure phosphat of lime next to this, then oxalat of lime, and ultimately the fusible crust enveloping the whole concretion.

This alternation of different species of calculi may, at first sight, appear to throw great difficulties in our attempt to cure this disorder upon chemical principles. But, on

* This crust often covers but a portion of the stone, the other portion being in this case sheltered from the calcareous deposition by the coats of the bladder which are in contact with it.

the other hand, it is somewhat encouraging to observe, that, since occasional variations in the state of the body can produce a total change in the nature of the urinary secretions, medicines may in all probability effect similar changes; and that therefore it is not unreasonable to hope that we may, at some future period, acquire a considerable control over those morbid secretions.

Compound calculi not stratified.

VIII. Compound Calculi, with their Ingredients intimately mixed. If under this denomination I were to place all calculi which contain some impurities, this class would include almost all urinary concretions; for there is hardly any calculus in which some traces of lithic acid, or of the phosphats, cannot be discovered. But I propose to refer to this head those substances alone which have no characteristic feature by which they may be considered as distinctly belonging to any of the other classes. Fortunately, calculi of this kind do not frequently occur. They may sometimes be recognised, however, by their more or less irregular figure, and their less determined colour; by their being less distinctly, if at

all, stratified, and by their often possessing a considerable hardness. When exposed to analytical processes, as will be detailed in a subsequent chapter, confused results are obtained, which soon betray their compound nature.

Calculus from the prostate.

CALCULUS FROM THE PROSTATE GLAND.— Calculi not unfrequently form in this gland, and produce symptoms described in another part of this Essay, which are often mistaken for the effect of stones in the bladder; and if any of these calculi be discharged, their appearance is so similar to that of lithic concretions, that, unless their chemical nature be ascertained, they will almost infallibly be mistaken for that species of calculus.* It is therefore of use to have dis-

* Sometimes also an error of the opposite kind may take place. Thus I remember the case of a foreign minister, who, whilst attended by a most eminent surgeon in London, passed a number of small brownish concretions, which were mistaken for calculi of the prostate, and the treatment was for some time conducted upon that supposition. Having, however, been requested to examine these calculi, I found them to consist of pure lithic acid; and upon an appropriate treatment being adopted, the complaint soon entirely disappeared.

tinct information as to the composition of these stones, and it is again to Dr. WOLLASTON that we are indebted for our knowledge on this subject.* They all consist of phosphat of lime, not distinctly stratified, and tinged by the secretion of the prostate gland. The phosphat of lime, in this concretion, is in the neutral state, without a redundance of the calcareous earth as in the earth of bones. The size of these stones varies from that of a pin's head to that of a hazel-nut; their form is more or less spheroidal; their colour is yellowish-brown, as may be seen in fig. 2. Plate IX., in which a section of a diseased prostate is represented, with the calculi contained in the enlarged cells of the gland. † In the same Plate, fig. 1., another form of the disease of the prostate is exhibited; here the calculi are inclosed in a cyst, formed in the right

* Philosoph. Transact. for 1797.

† The preparation is at St. Bartholomew's Hospital, in the collection of Mr. ABERNETHY, who kindly allowed me to have a drawing made from it. It is the same from which the calculi described in Dr. WOLLASTON's paper were obtained.

lobe of the enlarged prostate, and the two calculi represented on each side of fig. 2. were taken out of this gland.* The change of structure exemplified in fig. 2., is by far the most common form of the disease.

I have now given an account of the different kinds of calculi belonging to, or connected with the urinary passages, with the exception of two specimens which have appeared to me new and peculiar, and which I shall describe in the next chapter. There is another species mentioned by FOURCROY, in his elaborate classification of urinary calculi, under the name of *Uraï of Ammonia*; but as neither Dr. WOLLASTON nor Mr. BRANDE have been able to satisfy themselves of the existence of this substance in any of the calculi they have examined; and as I have also in vain looked for it in the various collections to which I have had access, I have not introduced it in my enumeration of those bodies. That, how- Urat of ammonia.

* This is the same case to which I have already had occasion to refer, page 10 and 17. The patient's name was WILD, and Mr. A. COOPER is in possession of the preparation.

ever, urat of ammonia is sometimes secreted by animals, I have lately had an opportunity of observing in the excrements, or what may perhaps more properly be called the urine, of the large species of serpent, known by the name of *Boa constrictor*, as I shall have occasion hereafter to notice. I am therefore far from denying that urat of ammonia may occasionally exist in human urinary calculi, especially as FOURCROY'S statement is confirmed by the authority of his accurate coadjutor, Mr. VAUQUELIN. But I confess myself not satisfied with the distinctive characters assigned to that substance, particularly as the frequent presence, in the lithic calculi, of urea and of the triple phosphat, both of which afford ammonia in abundance, may have given rise to the analytical results from which the existence of urat of ammonia has been inferred. The possibility of this has been satisfactorily shown by Mr. BRANDE*; but I do not think that his observations on the subject go the length of proving that the results in question *could not* have been produced by urat of ammonia.

* Philos. Transact. 1808, p. 230.

CHAP. IV.

AN ACCOUNT OF TWO CALCULI, WHICH CANNOT BE REFERRED TO ANY OF THE SPECIES HITHERTO DESCRIBED.

AMONGST the urinary calculi which I have had an opportunity of examining, I have met with two, which have appeared to me to differ in their properties from all those hitherto described; and which, therefore, I am inclined to consider as constituting two new and distinct species. As, however, I have yet met but with one single instance of each of these varieties, they may possibly be accidental and solitary productions; and unless other similar calculi should occur to future enquirers, these would hardly deserve any farther notice. A non-descript calculus.

The first of the calculi in question was put into my hands a few years ago by my friend and colleague, Dr. BABINGTON, who

had it from one of his patients, and wished to know its composition. I answered that it appeared to be an ambiguous substance, which was soluble both in acids and alkalies; but a considerable time elapsed before I gave it a more minute attention; and when upon closer examination, I found this calculus likely to prove a new substance, Dr. Babington had unfortunately forgotten the name of the patient, and lost sight of the circumstances of the case. Its properties appear to be as follows:—

Its properties.

1. It was, when entire, of an oblong spheroidal shape, and weighed only about eight grains.

2. Its texture is compact, hard, and laminated; surface smooth. It is of a reddish cinnamon colour, which is much heightened on adding caustic alkali to the calculus in powder. Between the red laminæ, faint whitish lines are perceived.

3. When the blow-pipe is applied, it crackles, splits into small pieces, turns black, and is ultimately consumed, leaving only a

minute particle of white ash. The smell it emits is that of an animal substance, and is peculiar, though feeble and not easily defined. It does not at all resemble that of the lithic acid, or of the cystic oxyd.

4. When exposed to destructive distillation, it crackles, splits into scaly fragments, blackens, and emits a fœtid ammoniacal liquor, from which carbonat of ammonia crystallizes in cooling; and a heavy yellowish oil.

5. When reduced to an impalpable powder by scraping, and boiled in water, the greater part of it is dissolved, and this solution slightly reddens litmus paper. If the clear liquor be decanted off, and allowed to cool, it covers itself with a white flocculent film, apparently not crystalline, which gradually subsides, forming a white incrustation; and if the glass be scratched with a pointed instrument, during or just before this deposition, white lines appear at the points of contact, as in the case of the ammoniaco-magnesian phosphat.

6. Caustic potash dissolves this calculus very readily, and it may be precipitated from this solution, by acetic acid, provided the latter be not added in great excess. It is also soluble in ammonia, and in the alkaline sub-carbonats.

7. The mineral acids also dissolve it, though not near so readily as the alkalies; so that a doubt may arise, whether acids may not act upon it merely through the water they contain.

8. The residues of its solution in the muriatic and sulphuric acids are white; and, as far as I was able to judge from the minute quantities of the calculus, which I was able to spare for experiments, no distinct crystals were formed. Concentrated sulphuric acid does not blacken this calculus.

9. When the solution of the new substance in nitric acid is evaporated to dryness, the residue assumes a bright lemon colour. This yellow residue is partly soluble in water, to which it communicates its colour.

The addition of an acid takes away this yellowness; but if caustic potash be added to the yellow substance, it instantly turns it to a more or less intense red colour, according to the degree of dilution; and upon evaporation it assumes a brilliant crimson hue, which however disappears on adding water, the yellow colour being reproduced, and remaining perfectly transparent. The previous action of nitric acid is necessary for these singular changes; for if the potash be added to the pure xanthic substance, such as deposited by water, no change of colour takes place. The residue of the solution of xanthic oxyd in water produces the yellow substance, when treated with nitric acid, just the same as the calculus itself.

10. The new substance is insoluble in alcohol or ether.

11. It is but very sparingly soluble in acetic acid.

12. It is insoluble, or nearly so, in oxalic acid.

13. It appears to be insoluble, or nearly so, in bi-carbonat of potash, or saturated carbonat of ammonia.

Its distinguishing characters. Upon the whole, this calculus appears to be a substance *sui generis*, and will probably be found entitled to be considered as an oxyd, though it is certainly much less soluble in acids than the cystic oxyd.

It is considerably more soluble in water than lithic acid, and is abundantly distinguishable from it by the lemon colour it forms when acted upon by nitric acid, and by its smell when burnt.

It is as easily distinguished from the cystic oxyd, since the latter forms a white residue on evaporating its nitric solution; has a smell quite peculiar to itself; is not formed of laminæ; and is rather more soluble in alkalies, and much more soluble in acids than the new substance in question. Should there remain any doubt respecting the peculiar nature of this calculus, I would beg to add that both Dr. Wollaston and Dr. Prout, have examined

its leading properties, and have expressed their conviction that it could not be referred to any of the species hitherto described.

It is so difficult to find an appropriate and unexceptionable denomination for a new substance, that it is with reluctance I propose one for this, especially as a similar production may possibly never again be noticed. The term *Xanthic Oxyd*, from ξανθος *yellow*, has occurred to me as an appropriate name, because it alludes to a striking, and probably characteristic property of the substance in question, (that of forming a lemon-coloured compound when acted upon by nitric acid,) and yet does not imply any systematic notion as to its composition. Name proposed.

The other non-descript urinary concretion came to my knowledge under the following circumstances. Mr. ASTLEY COOPER sent me, about four months ago, a spherical calculus of the size of a large pea, to which were annexed the words, 'Is it cystic or uric?' I answered, after a slight examination, that it was neither of the one nor of the other Another non-descript calculus.

kind; but that it appeared to consist of hardened animal matter, probably of the albuminous kind. Upon closer examination it was found to possess the following properties: —

1. It had a yellowish brown colour, somewhat resembling bees' wax. Its hardness was also nearly that of bees' wax. Its surface was uneven, but not rough to the touch; its texture rather fibrous than stratified, and the fibres apparently radiating from the centre. It was somewhat elastic.

2. When exposed to the flame of a spirit-lamp, it took fire, swelled out, blackened, and ultimately passed to the state of a light spongy carbonaceous mass. In burning, it emitted an animal smell, which did not at all resemble that of the lithic, cystic, or xanthic calculus.

3. It was insoluble in water, or muriatic acid; but when boiled with caustic alkali, it formed a soapy solution, from which the substance in question was precipitated by muriatic acid.

4. Nitric acid dissolved this substance, though much less readily than the lithic or cystic calculus; but this solution, on being evaporated to dryness, did not produce any red or yellow stain whatever.

5. When boiled in very dilute acetic acid, it first swelled to a greater size, but was at last dissolved; and on adding prussiat of potash to this solution, a yellow precipitate was formed. *

All these properties correspond exactly to those of fibrine, and therefore if the recurrence of similar concretions should render it necessary to give them a name, they might, I think, without impropriety, be called *fibrinous* calculi. — In the mean time it may not be useless to give a few particulars of the case, which I collected from the patient himself. This gentleman, who appeared to be from 50 to 55 years of age, states that he has been, for the last two or three years, labouring under symptoms of

Name proposed.

Outline of a case of fibrinous calculus.

* This is a valuable test of fibrine, first pointed out by Berzelius.

urinary calculi, recurring in the form of severe paroxysms, of which he has already had several. He never has any pain in the kidneys or ureters, but during the paroxysms he has 'great pain and irritation about the neck of the bladder, with bloody urine, and frequent difficulty in passing it. He has also pain at the extremity of the penis. Under the circumstances just related, he has already passed three calculi of the species above described, and all nearly of the same size. The pain each time has been relieved after the stone has been discharged. The last time, after a paroxysm of great torture, the stone was found in the patient's bed, having been passed without his knowledge. During the intervals between the paroxysms, he feels great inconvenience from the jolting of a carriage on the stones, but otherwise he is free from pain, has not very frequent desire to void his urine, and there is, he says, no morbid appearance in this secretion, except that 'sometimes it has rather a blackish tinge.' He has employed alkaline medicines at different periods, with good effect; and is now taking magnesia and uva ursi with some apparent benefit.

CHAP. V.

OF THE COMPARATIVE FREQUENCY OF THE DIFFERENT SPECIES OF URINARY CALCULI.

ALTHOUGH no immediate practical inferences are likely to result from an enquiry into the comparative frequency of the different species of urinary calculi, yet it is an object of considerable curiosity and interest to obtain some accurate knowledge on this point. In making an attempt of this kind, however, an unavoidable difficulty occurs, which is that of establishing precise characters of distinction between species that are of a compound nature, and therefore often ill-defined, and sometimes even running into each other by insensible gradations. This impediment to the acquisition of regular comparative documents could only be entirely removed by such

Difficulty of the enquiry.

accurate analyses as may perhaps never be accomplished. But by contenting ourselves with approximations or general views of classification, and waving theoretical accuracy, we may still be able to form interesting conclusions. Of the 506 calculi, in the valuable collection at Norwich, to which I have so often referred, I was able to ascertain, by chemical examination, the composition of only 181 specimens, during the time I spent there for that purpose. But I considered that number as quite sufficient to enable me to draw pretty accurate inferences, as to the general state of that collection, especially as the specimens subjected to examination were purposely taken from various periods. This is by far the most extensive document I am able to offer; but I must not omit to observe that when these calculi were entire, which was frequently the case, I could only ascertain the nature of the external surface, unless the layer contiguous to this presented spots sufficiently uncovered to admit of being examined.

Summary view of results.

The following is a summary view of the results in question, with the addition of

the number of deaths belonging to each species:

From the Norwich collection.

Species of Calculi.	No.	Deaths.	Proportion of fatal Cases.
1. Lithic calculi, in which the character was well defined, and lithic acid manifestly prevailing - - - - -	66	9	1 in $7\frac{1}{3}$
2. Calculi, consisting of phosphat of lime, either pure, or alternating with triple phosphat - - - - -	4	0	—
3. Fusible calculi, often mixed with triple phosphat - -	49	8	1 in $6\frac{1}{6}$
4. Mulberry calculi - - -	41	2	1 in $20\frac{1}{2}$
5. Calculi formed of distinct alternating layers, viz.			
Lithic and mulberry - 15 Mulberry and triple - 1 Fusible and lithic - - 1 Fusible and mulberry - 2	19	6	1 in $3\frac{1}{6}$
6. Undefined mixture, not disposed in distinct layers	2	—	—
TOTAL - - -	181	25	1 in $7\frac{1}{4}$

Inferences. It would therefore appear, so far as depends upon the evidence of this document, that the lithic calculus, which Scheele supposed to be the only species of urinary concretion, constitutes hardly one third of the total number of stones which occur in the urinary passages; and that the fusible comes next, in regard to frequency. It appears also that the numbers of either the fusible or mulberry calculi amount only to about two-thirds of the number of the lithic calculi; and that those concretions which are evidently of a compound nature, amount to only about one half of the mulberry species.

It will also be observed that by far the greatest proportion of deaths has been amongst patients labouring under calculi of the compound or mixed kind; and I am enabled to add, by a more particular reference to my notes, that no less than 5 deaths were annexed to the 15 cases of alternating lithic acid and oxalat of lime: whilst, contrary to all expectation, the strongly characterized mulberry, with its usual rough tubercular surface, yielded a much smaller proportion of fatal cases than any other species. This result is the more curious

as it seems to show, that it is not so much the mechanical irritation of the stone, as the particular diathesis of the urinary secretions which influences the event of the operation.

The collection of calculi in the museum of Guy's Hospital, which I have examined more at leisure, and probably with greater accuracy than the preceding, presents the following results: Results from the collection at Guy's Hospital

1. Lithic calculi, or stones in which the lithic character obviously prevails; including 6 decrepitating calculi, formed of lithic acid mixed with a small portion of oxalat of lime - - - - - - -	22
2. Phosphat of lime nearly pure -	3
3. Triple phosphat, that is, calculi presenting externally a crystalline sparkling appearance - - - -	2
4. Fusible calculi - - - -	24
5. Mulberry - - - - -	22
6. Compound calculi in distinct layers 6 } ——— without layers 7 }	13
7. Cystic oxyd - - - -	1
	87

Inferences. In this collection, therefore, the fusible, the mulberry, and the mixed calculi, bear to each other nearly the same ratio as in the former; but the proportion of lithic calculi is much smaller in this; a result the more remarkable as it tends to show that the calcareous nature of the eastern counties of England, to which the greater prevalence of the stone in those districts has been generally ascribed, is in all probability noways connected with this disease, since the earthy species of calculus is comparatively much more frequent in London than in the districts in question.

The author's private collection. I had first intended in arranging these documents, to add to them the particulars of a small collection of my own, containing about 50 calculi; but I have, on second consideration, thought it better to abstain from doing so, because these calculi having been put into my hands for the purpose of being analyzed, on account, in most instances, of their not being possessed of distinct external characters, they could hardly be considered as affording a fair average of the different species. Yet I

may generally state that with the exception of the disproportionate number of specimens of cystic oxyd which it contains, my private collection agrees remarkably well (in regard to the proportions which the different species of calculi bear to each other) with that of Guy's Hospital.

CHAP. VI.

OF THE ANALYSIS OF URINARY CALCULI, WITH A VIEW TO THEIR EASY DISCRIMINATION.

THE general remarks which I have to offer on this head have in a great degree been anticipated in the preceding pages. But the particular object of this section will be to point out to medical practitioners, and more especially to those who are not conversant with chemical manipulations, a few tests or directions by means of which they will easily be able to ascertain the prevailing nature of urinary concretions.

A blow-pipe, a candle, and a small pair of tongs to hold a particle of the calculus under examination, and enable the operator to direct the flame against it, are, in most instances, the only apparatus required to ascertain its nature. As, however, this is not always sufficient, I shall describe, and represent by a sketch, such instruments as

appear to me best calculated to form an apparatus adapted to the examination of all kinds of urinary calculi; and I shall afterwards point out the simplest and easiest modes of analyzing these bodies.

Tests of lithic acid.

When a calculus is of a brownish colour, compact, rather hard, smooth or nearly so, and of the shape of a flattened oval, there is great probability of its being of the lithic kind. Often, however, these appearances are but imperfectly marked, and at other times they are fallacious. The blow-pipe, in most instances, will be sufficient to enable us to identify the lithic calculus. For this purpose a fragment, not larger than a pin's head, is detached from the stone with the point of a knife, and being held by the extremity of a small and slender pair of platina tongs*, is exposed to

* These tongs may be made of a slip of thinly laminated platina, (Plate X. fig. 2. or 3.,) or of brass pointed with this metal. Platina is preferable for this purpose to any other metal, on various accounts; first, because it is not acted upon either by intense heat or by the usual chemical re-agents; and, secondly, because it is a bad conductor, so that the heat applied to the

the flame of the blow-pipe.† If the lithic acid be its principal ingredient, the fragment blackens, emits a smoke having a

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extremities of the tongs, however intense, does not reach the fingers of the operator, provided the tongs be made of very slender materials, a circumstance otherwise desirable in experiments performed with the blow-pipe, and upon minute quantities of matter. Mr. Cary, optician and instrument-maker in the Strand, has long been in the habit of making platina utensils of this and all other descriptions.

† The particular shape of the blow-pipe, except as to its being more or less portable, is of little consequence, and it may indifferently be made of various materials. It may be either a glass tube with a bulb or swelling to condense the moisture of the lungs, and a beak to form the jet, as represented in Plate X. fig. 1., or it may be of the more convenient construction fig. 11. This blow-pipe contains, like the former, a circular enlargement to condense the moisture; but the smaller end *d* is moveable in all directions round its axis, so that any degree of obliquity may be more easily given to the flame. Short jet-pipes made of platina, such as represented fig. 12., having orifices of different diameters, are easily fitted to the extremity, *d*, so as to form a jet of the requisite strength. Either a common candle, or a spirit-lamp, such as represented fig. 13., may be indifferently employed for experiments with the blow-pipe. If a candle be used, wax is preferable to tallow.

I am aware that some practice is required to use the blow-pipe properly, and that many persons are alto-

strong and characteristic odour, and is gradually consumed, leaving a minute quantity of white ash, which is usually alkaline.

The next feature by which lithic acid may be easily recognised, is its being readily dissolved in caustic alkali. This may be effected simply by scraping off a little of the calculus in a glass capsule or watch-glass, and pouring upon it a few drops of caustic potash; on exposing this to the heat of a lamp*, the lithic matter is immediately dissolved, leaving a residue

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gether incapable of making use of this instrument. In this case, the late contrivance of Mr. Brooke, commonly called Newman's blow-pipe (which is described in the 2d Volume of the Journals of the Royal Institution, and in other recent chemical works), will be found very convenient. Here a quantity of air is condensed in a strong vessel by means of a syringe, and being suffered to rush out through a capillary orifice, whilst the flame of a lamp is exposed to the current, the desired blast is produced without the assistance of the mouth or hands of the operator.

* The glass capsule may be placed over the lamp, fig. 10., by means of a small stand, fig. 9., carrying circular supports (*a*, *b*,) of different sizes; or it may be held with the hand, as in fig. 7., resting upon an ap-

more or less considerable, according to the proportion of the other substances contained in the calculus; and by adding to this solution any acid, not excepting the carbonic, a white precipitate, consisting

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propriate support. A slip of laminated platina, or simply of common tin cut in the form of a crescent, and fastened to a wooden handle, as represented fig. 8., makes the most convenient support, as it may be slided under the capsule to take it up from the table and lay it down again, without handling it with the fingers. Dr. WOLLASTON, by whom so many useful contrivances of this kind have been introduced into chemical manipulations, is in the habit of using, for experiments upon a very small scale, an apparatus still more simple, though equally appropriate. It is merely but a narrow slip of common window-glass, fig. 17., upon which he performs his solutions, precipitations, and evaporations on extremely small quantities of matter, generally a single drop, and yet without any want of distinctness in the results. Several operations of this kind may be carried on simultaneously on the same slip; and glass being a very bad conductor of caloric, one extremity of the slip can be held over the flame of the lamp, without the heat incommoding the fingers at the other end.

Amongst the practical contrivances of Dr. WOLLASTON, the phial or dropper, fig. 16., for the purpose of easily dropping out minute quantities of water, deserves to be mentioned. This is simply a phial, through the cork of which a piece of bent tube is introduced, the outer end of the tube being drawn into a

of pure lithic acid, is immediately formed. Lastly, if to a small particle of lithic calculus, however impure, a drop of nitric acid be added and heat applied, the lithic acid disappears; and if the solution be evaporated to dryness, the residue assumes a beautiful pink or carmine colour. This residue is soluble in water, to which it imparts its peculiar colour. Such are the tests by which lithic acid can always

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small orifice. The phial being partly filled with distilled water, one drop, or any number of drops in succession, may be forced out by the heat of the hand which expands the air contained in the vessel, and this is done with remarkable quickness and convenience. This apparatus cannot be used for acids or alkalies, or in general for tests which would be acted upon by the cork. But in order to obviate this, I contrived a few years ago, and have long been in the habit of using, test-phials such as the one represented in fig. 6., the glass stopper of which is drawn into a rod of sufficient length nearly to reach the bottom of the bottle; so that on taking out the stopper, a drop of the test is found adhering to the glass rod, from which it is easily shaken off. To persons unaccustomed to chemical manipulations upon a small scale, such details may appear almost puerile. But their practical utility will soon be felt by those who may be induced to adopt this mode of conducting chemical operations.

be detected, even when in a state of great impurity; when however its proportion is very small, the results may be more or less dubious, and a more elaborate analysis may be required.

Tests of phosphat of lime.

The indications by which phosphat of lime, or the bone earth calculus, may be easily identified, independently of its external characters, are very simple. Before the blow-pipe it first blackens, but soon afterwards becomes perfectly white, still retaining its form, and not exhibiting any appearance of fusion, unless the most intense heat be applied, such indeed as very few persons are able to produce by the blow-pipe. This calculus, when pulverised, is readily dissolved by dilute muriatic acid, and if the excess of acid be not very considerable, the lime may be precipitated in the form of an insoluble compound, by oxalat of ammonia.

Tests of the ammoniaco-magnesian phosphat.

The ammoniaco-magnesian phosphat, though scarcely ever found without an admixture of some other substance, is yet often discernible by its whiteness, and by its crystalline sparkling appearance. If, however, chemical tests be required, a few

particles of this salt (whether deposited in the form of a white sand by morbid urine, or detached from a calculus) may be exposed to a gentle heat, or treated with a few drops of caustic potash, by either of which means a pungent smell of volatile alkali will be immediately disengaged. If the heat of the blow-pipe be urged, the phosphat of magnesia which remains, after the expulsion of the ammonia, becomes opaque, and is capable of undergoing an imperfect fusion. This calculus is readily soluble in dilute acids, much more so indeed than phosphat of lime; and if these solutions be treated with ammonia in excess, the triple crystals re-appear.

The fusible calculus is easily distinguished, when exposed to the flame of the blow-pipe, by the property from which it has obtained its name. It melts on the heat being moderately urged, bubbles up and runs into a globule of a pearly appearance, and sometimes perfectly transparent. It is readily dissolved by acids, and in particular by the dilute muriatic acid, and the lime and magnesia can be precipitated in

Tests of the fusible calculus.

succession from these solutions by appropriate re-agents. Thus if the lime be separated by oxalat of ammonia, and if ammonia be added to the clear solution, an ammoniaco-magnesian phosphat immediately appears, and subsides with its usual appearance. * A more complete and scientific mode of analyzing this calculus was pointed out (Chap. III. p. 72.) when its chemical nature was first explained.

Tests of the mulberry calculus.

The mulberry calculus, or oxalat of lime, is often abundantly distinguishable by its external appearance; but this is by no means always the case. Its most obvious chemical character is to swell out, when exposed to heat, and to expand into a kind of white efflorescence, which, when brought into contact with paper stained with the juice of violets and slightly moistened, turns it green; or if with turmeric, turns it

* The peculiarity of this salt is, that, if while forming the inside of the vessel be scratched with a glass tube or any pointed instrument, the triple crystals are most disposed to form on those parts of the vessel which have been scratched, producing the appearance of white lines wherever the tube has rubbed the vessel.

red. This white alkaline substance is nothing but caustic lime deprived of its oxalic acid, this acid being readily destroyed by the application of heat, so that the flame of a spirit-lamp, without the assistance of the blow-pipe, is in most instances sufficient to produce this effect. In some cases, however, calculi of this species are more refractory, particularly those which have not the usual mulberry-shaped surface, owing to a mixture of other calculous matter, and in particular of lithic acid. This variety is apt to crackle and decrepitate when heat is applied.

T th ox...

The cystic oxyd may be easily recognised by its unstratified and homogeneous structure, by its peculiar colour, and waxy appearance, and by its peculiar smell when heated; but should any other test be wanted, the great solubility of this substance, both in acids and alkalis, is a criterion by which we can scarcely be deceived.

Mode of examining compound calculi.

With regard to the compound calculi, if their different ingredients be disposed in

layers, it is only necessary, in order to ascertain their nature, to examine in succession particles detached from these respective layers. But if intimately mixed, it is rather from the ambiguous results yielded by the various tests I have just pointed out, than by any positive character, that we are first led to suspect their being of a compound nature; and it is by an appropriate combination of the methods above described, that we are enabled to ascertain their various ingredients.

I have thus pointed out the summary modes of analysis by which, with very little chemical skill or knowledge, and with an extremely simple apparatus, the various kinds of urinary calculi may be easily distinguished. It is not with the pretension of offering any thing new or important, to professed experimental chemists that I have introduced these details; but merely to enable those who may feel inclined to avail themselves of these hints, to select and procure, at the smallest possible expense, the apparatus necessary for carrying on experiments of this kind; and to obtain with

great ease useful practical knowledge, upon a subject which is commonly supposed to present great difficulties, and to require considerable chemical information.

CHAP. VII.

ON SOME OTHER KINDS OF ANIMAL CONCRETIONS, NOT BELONGING TO THE URINARY PASSAGES, BOTH IN MAN AND OTHER ANIMALS.

Object of this digression.

AS medical men are sometimes called upon to give an opinion on the nature of various animal concretions, which have not originated in the urinary passages; and as doubts may occasionally arise with respect to their origin, which, in most instances, can be removed by a chemical examination, a few miscellaneous observations on this point may be acceptable.

Concretions found in various viscera.

The small concretions so commonly found in the pineal gland, and those which occasionally occur in the pancreas, the mesenteric glands, the spleen, the uterus, and the lungs, have been examined by different chemists, and have been found to consist of phosphat of lime, combined with variable

proportions of animal matter. Pulmonary concretions, however, have in a few instances been observed to contain also carbonat of lime; and I have myself met with a case of this description. I have also a portion of the lungs of a negro, (which was given me by Dr. WOLLASTON) on the surface of which there is a white incrustation of triple phosphat.

In the salivary glands.

Small concretions occasionally occur in the salivary glands, especially the parotid and sublingual. They have been examined by FOURCROY*, and by Dr. BOSTOCK†, who found them to consist of phosphat of lime, with small portions of animal matter. The tartar of the teeth is of the same nature.

Calculi of the intestines.

As to concretions of the intestines, although they are frequently met with in the alimentary canal of quadrupeds, especially in the colon, they are comparatively very rare in the human intestines, where indeed they do not appear to constitute any particular

* FOURCROY's Systême, &c. ix. p. 367.
† NICHOLSON's Journal, xiii. 374.

species, but rather to depend upon accidental circumstances. The most remarkable calculus of this kind which I have ever seen, was one found in the rectum of an infant, born with an imperforated anus; but in whom there appeared to be a communication between the rectum and the urinary bladder. This calculus was about the size of a walnut; it had a kind of brown crust, as if stained by fæces, but was whitish in its interior. It was light, spongy, not distinctly stratified, and very friable. When chemically examined, it proved to be principally of the fusible kind, with sparkling crystals of triple phosphat dispersed throughout its texture. It had no perceptible nucleus, and was much lighter and more friable than any urinary calculus I have ever seen.

Fusible calculus found in the rectum.

Some human intestinal concretions, entirely composed of common carbonat of magnesia, were described some time ago by Mr. E. Brande, who satisfactorily accounted for their formation, the patients having been in the habit of making a daily and most wanton use of magnesia, which, with the assistance of a little animal mucus, had

Magnesian calculus.

consolidated into masses of a formidable magnitude. *

Six or seven years ago, I had an opportunity of examining some human intestinal concretions which appeared to me peculiar and curious; and as another instance of the same kind has since occurred, it may be worth while to relate here the particulars which I recorded at the time.

Caseous concretions.

The largest of these bodies † was of a flattened oval, but somewhat triangular shape, about $\frac{1}{4}$ of an inch in thickness, and near $1\frac{1}{2}$ inch in circumference; and it weighed 12 grains. The others were smaller and more globular. Their surface was

* See Journal of the Royal Institution, vol. i. — Concretions exactly similar to these were described several years ago by Dr. Henry. See Monro's Morbid Anatomy of the Gullet, &c. p. 34.

† These concretions were put into my hands for examination by Mr. A. Cooper, from whom I learnt that they had been discharged by a female patient, under circumstances which made it questionable whether they had proceeded from the rectum or from the urethra.

smooth and unctuous like wax, and their colour yellowish. They were tender and easily broken into fragments. They had an offensive smell resembling that of decayed cheese. On being exposed to heat, they became brown, bubbled up like coagulated animal matter, and threw out a thick smoke, with a smell of toasted cheese. This substance was partly soluble in alcohol, in pure potash, and in oil of turpentine. The residue of the solution in turpentine was tougher, and resembled cheese more closely than the original substance. The residue of the solution in alkali was soluble in turpentine, and *vice versa*. The portion taken up by alcohol subsided on cooling, or on adding water. Upon the whole, these concretions appeared to me, and to Dr. WOLLASTON, to whom I showed them soon afterwards *, to be either pieces of undigested cheese formed into balls by the

* Dr. WOLLASTON himself, a few years after this, had several concretions of this kind brought to him for examination by a medical practitioner; they proved precisely of the same nature as those I have just described, and had been discharged by a patient whilst using a milk diet.

action of intestines, or portions of caseous matter actually formed in the intestines from milk taken as nourishment by the patient, and coagulated by the gastric juices into those undigestible masses.

Another singular species of intestinal calculus was given me last year by a zealous and intelligent medical student from Portugal, Mr. SILVEIRA, who had it from the present professor of anatomy of Edinburgh, Dr. MONRO, in whose collection, Mr. SILVEIRA said, many similar ones were preserved. The very peculiar appearance of this calculus, and the circumstance of its occurring frequently in Scotland, whilst it has never been observed in this country*, made me solicitous of ascertaining its nature. It was externally covered with a thin whitish smooth earthy crust; but when cut open, it presented a velvetty compact brownish sur- Oaten calculi.

* Since this was written, Dr. BOSTOCK, late of Liverpool, now of London, showed me a calculus of this kind which was voided by a labouring man in Lancashire, a district in some parts of which oat-cake is in common use as an article of food amongst the lower classes.

face, alternating with thin concentric laminæ of the white earthy substance. The crust and white laminæ I found to be fusible, and soluble in acids; and in short to consist of the two phosphats; but the velvetty substance appeared to resist the action of the usual chemical agents, and when exposed to the blow-pipe, burnt away with a smell of straw. I mentioned these circumstances to Dr. Wollaston, and showed him the calculus, which he thought curious and worthy of further examination. He found the velvetty substance to consist of extremely minute vegetable fibres, or short needles pointed at both ends, which he immediately conjectured to arise from some kind of food peculiar to Scotland. For some time, however, he failed in his attempts to trace this substance to its origin. But the ingenious Mr. Clift, of the College of Surgeons, to whom the subject was mentioned in conversation, having put the question 'whether this fibrous substance might not proceed from oats,' Dr. Wollaston was induced to examine the structure of this seed, and the result fully verified Mr. Clift's conjecture. If the oat seed be

denuded of its husk, minute needles or beards, forming a small brush, are seen planted at one of its ends. Dr. WOLLASTON, on examining these needles, and comparing them with similar ones detached from the calculi, and forming the velvetty substance in question, satisfied himself beyond all doubt of their perfect identity.*

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* On referring to Dr. MONRO's 'Morbid Anatomy of the Gullet,' &c., I find that the learned author has given in that work an elaborate sketch of the history of intestinal calculi. From the aggregate of his remarks on the subject, it would appear that concretions of this class are in general very rare productions, though his father's collection contains 42 intestinal calculi, which (with the exception of one only) are all of the species just described. Dr. MONRO wishing to render the history of these bodies quite complete, not only favoured the public with a coloured plate of the calculus in question, but he also called to his aid the author of the valuable System of Chemistry, Dr. THOMSON, and the celebrated Professor of Mineralogy, Mr. JAMIESON. Dr. THOMSON analyzed the calculus with great care, and his report was published at full length in Dr. MONRO's treatise (Morb. Anatom. p. 44). Dr. T. detected and described minute quantities of various earthy and saline substances contained in them; but when he came to the mass of vegetable matter, which forms the chief bulk of the calculus, and gives it its peculiar character, the powers of chemical analysis, however skilfully conducted, failed in

Other concretions of vegetable origin.

I cannot resist the opportunity of relating here some other instances of supposed intestinal concretions, which have occurred under my own observation, and appear to me possessed of some interest, not only from the attention they excited in the patients or their medical attendants, but also from their affording further instances of successful attempts to trace new and singular effects to familiar causes.

Within the last few years, small granular concretions have, at four different times, been put into my hands for examination, by patients suspected to labour under he-

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informing him of its real origin, and only led him to the general conclusion, that ' it is undoubtedly of a peculiar nature, differing from any animal and vegetable substance hitherto examined.'

The object of Professor JAMIESON's co-operation was, to give to the nomenclature of these calculi that accuracy of expression for which the mineralogical school to which he belongs is so remarkable. Accordingly we find that some of them are *tuberose*, others *botryoidal*, others *pyriform*: but they are all *fibrous*, *feel fine and rather meagre*, qualities by which they can easily be recognised. Perhaps the word *avenaceous* would be a useful addition to the Wernerian characters.

patic affections, and whose attention had, on that account, been particularly directed to the appearance of their evacuations. These grains were of a pale brownish colour, about the size of a large pin's head, sometimes single, sometimes united two by two, but being all evidently of a common origin. On exposing them to the flame of the blow-pipe they burnt with a bright flame, and a vegetable smell, leaving a particle of white ash.

When these concretions were shown to Dr. Wollaston, he suspected, after some unsuccessful conjectures, that they might perhaps be those small woody knots which are often found in certain pears; and upon close examination the identity appeared unquestionable. The only difference that could be perceived between these supposed intestinal calculi and the woody particles in question, was the latter being of a paler colour than those which had passed through the alimentary canal, in which they had been more or less tinged by the intestinal secretions.

Other pseudo-concretions.

The last case which I shall relate, presents another instance in which a very natural explanation of the supposed formation of extraordinary bodies in the intestines, was obtained by an attentive examination of their external appearance, without the aid of chemical analysis.

A philosophical gentleman of delicate health, and of a disordered hepatic system, observed in his stools a number of small red globular bodies, each of which had in its centre two black opaque spots, discernible through its transparent envelope, and some of these were entirely surrounded by a very thin and delicate membrane. These bodies strongly attracted the attention of the patient, who perceiving that they had an organic structure, supposed them to be peculiar animals connected with his disorder. Dr. WOLLASTON, to whom they were shown, suspected, on a first inspection, that they might be some species of seeds; but he soon afterwards satisfied himself that they were of an animal nature, and that, in fact, they were nothing but lobsters' spawn, a very indigestible substance, of which the

patient acknowledged to have eaten about the time he passed these bodies.

Coffee-ground substance.

There is a substance which is often passed by stool, in a variety of diseases, and scarcely deserves the name of concretion; yet it may not be superfluous to notice it in this place. I allude to the black particles, commonly called *coffee ground*, which are apt to appear in ill-conditioned stools. This substance leaves, after combustion, a white ash, which appears to be phosphat of lime, and in all probability arises from coagulated blood thrown out by the capillary arteries of the intestines.

Instances of wilful deception.

It sometimes happens, from causes which it is not always possible to comprehend, that persons apparently respectable, produce small stony bodies, as having been generated by disease and discharged from some of the natural passages, though they prove beyond all doubt, upon examination, to be true mineral productions; most frequently small pebbles, or coarse siliceous sand. As no such bodies, unless swallowed on purpose, or by accident, are ever found in any

of the excretory passages, it is necessary that a medical man should be upon his guard, when called upon to give an opinion on occurrences of this nature.

Calculi from the intestines of quadrupeds.

I have already observed that calculous masses are often found in the stomach and intestines of large quadrupeds, particularly of the horse. These have been repeatedly examined, especially by FOURCROY and VAUQUELIN, and may be generally stated to consist of the ammoniaco-magnesian phosphat, most frequently alone, though sometimes combined with phosphat of lime. * All the specimens which I have had an opportunity of examining have appeared to consist entirely of the triple phosphat in a very compact state. In a large calculus of this kind which was found in the

* The calculi formerly so much celebrated, and held in superstitious estimation for their medicinal powers, under the name of *Bezoars*, are concretions found in the stomach and intestines of various quadrupeds, such as the horse, the elephant, the goat, &c. They mostly consist, according to FOURCROY, of the triple phosphat, with various proportions of vegetable and animal colouring matter. They appear to be most frequent in warm climates, and those from the east were the most esteemed.

intestines of a rhinoceros, and given me by Dr. WOLLASTON, the triple phosphat is disposed in layers round a hazle nut, alternating with thin laminæ of phosphat of lime. The calculus is broken through its centre, and the fracture exhibits a radiated as well as a laminated structure.

Balls of hair, closely felted together, are frequently found in the intestines of quadrupeds. I have examined one of this kind which was taken from an ox, and was entirely covered with a thin smooth dark coloured crust, consisting of phosphat of lime and animal matter.

The urinary concretions which are frequently found in the bladder or kidneys of various quadrupeds, generally differ from those of the human subject in containing no lithic acid, and in consisting principally of carbonat and phosphat of lime, cemented by animal matter. Calculi of this species have been found by FOURCROY and VAUQUELIN in the bladder of the horse, the sow, the rabbit, and the ox. Mr. BRANDE examined a calculus from the kidney of a horse

Urinary concretions in animals.

which consisted of phosphat and carbonat of lime*; and I have examined one of the same kind which gave a similar result. Mr. BRANDE also examined a calculus from the kidney of a sheep, and found it to consist of the same ingredients. Both Dr. PEARSON and Mr. BRANDE have found calculi from the bladder of the horse to consist of the two phosphats, with some carbonat of lime and animal matter. There is a species of small calculi, not unfrequently met with in the bladder of the ox, which Mr. B. has found to consist entirely of carbonat of lime and animal matter. He has also analyzed a calculus from the bladder of a dog, which was of the fusible species, consisting of the two phosphats. Another calculus, from the bladder of a hog, consisted entirely of carbonat of lime and animal matter, a result which perfectly coincides with an analysis I lately made of a round and compact calculus, both laminated and radiated, which was found in the bladder of a pig, and in which I could not detect an atom of either phos-

* Philos. Transact. for 1808.

phoric acid or magnesia. And lastly, a calculus from a rabbit's bladder was found to consist of phosphat and carbonat of lime. Calculi are also liable to form in the bladders of rats, which, according to Fourcroy and Vauquelin, consist of the earthy phosphats.

Though lithic acid has been detected in the droppings of birds and in the urine of some animals, especially the camel, I believe it had never been observed in animal concretions, except in man, till Dr. Prout analyzed the excrements of the boa-constrictor, and found that substance to yield upwards of nine-tenths of its weight of lithic acid, and to contain ammonia.* These excrements, which are properly concrete urine, (though voided along with the contents of the intestines, as is the case in birds) appear in the form of white, chalk-like, friable, unstratified fragments, or scybalæ, which, at the moment they are discharged, are of the consistence of stiff dough, but soon acquire the hardness and friability

* Thomson's Annals of Philos. for June 1815, vol. v.

just described. Dr. Wollaston and myself having examined a specimen of this kind, found it, like Dr. Prout, to consist of urát or lithiat of ammonia, a substance of which I was previously inclined to question the existence. The presence of this substance however, in urinary calculi, I still think very doubtful, especially because, since it is so easily discoverable in the excrements of the boa-constrictor, it is not probable that the English chemists would have overlooked it so long in the human calculi, which they have so often and so successfully submitted to chemical examination. Besides the specimen of lithiat of ammonia from the boa-constrictor, for which I was indebted to Dr. Prout, the same gentleman also favoured me with a specimen of another excrementitious substance from the same animal, which was said to be cast up or vomited during the process of digestion. This appeared in the form of a light, spongy, brownish mass, in which some of the hair of the rabbits devoured by the serpent was distinctly seen. This substance I did not find to contain any lithic acid, but it consisted chiefly of phosphat of lime, and ap-

peared to be nothing but the indigested residue of the food of the animal.

Gouty concretions.

I must not omit to mention here the subject of gouty concretions, those chalk-like indurations which appear in joints which have been long subject to gout, and which Dr. WOLLASTON * has shown to consist of lithic acid and soda. This substance is white, soft, and friable; it is but sparingly soluble in boiling water, but it is readily dissolved in caustic potash. The soda may be easily separated from the lithic acid, by the sulphuric or muriatic acids.

Biliary calculi.

The only species of animal concretions of which I have not yet taken notice, is that of biliary calculi. These, it is well known, vary very much in size and external appearance, and admit also of considerable differences in their chemical composition. But they have all certain features by which they may be easily distinguished. Such are their properties of being lighter than water, and soluble partly in alcohol or ether,

* Philos. Transact. for 1797.

and partly in alkaline lixivia. They in fact all contain the substance called by FOURCROY *adipocire*, the name of which expresses its chemical nature; and their varieties of colour and appearance are to be ascribed to the nature and various proportions of the bile with which they are more or less combined. The biliary calculi of the ox differ from those of the human species, probably in their partaking much more of the nature of bile; their colour is a beautiful yellow, so as to render them useful pigments; and they possess properties identical with those of the yellow matter of the bile.

CHAP. VIII.

OF THE CHEMICAL AND PHYSIOLOGICAL PRINCIPLES TO BE ATTENDED TO IN THE TREATMENT OF CALCULOUS DISORDERS.

ON my entering upon this subject, I think it necessary to premise, that, in endeavouring to apply chemical principles to this branch of medical practice, no reasonable expectation can be entertained that calculi lodged in the urinary organs, and already too large to be discharged by the natural passages, can be actually dissolved by any mode of internal treatment. The only benefit which we may with any confidence expect from medicine in this disease is, either to prevent the increase of calculi already formed, or, what is still more important, to guard the constitution of those who are subject to the disorder, against the prevalence of the particular diathesis from which it arises. But although we cannot materially affect large concretions by medicines, on account of the powerful resistance which the

Probable limits of the powers of medicine.

cohesive force of such calculi, and the small extent of surface which they present in proportion to their mass, necessarily oppose; yet there certainly are cases in which some impression may be made upon small calculi or gravel, so as to blunt their sharp edges, and enable them to be discharged by the urethra with less difficulty or inconvenience. At all events, since in attempting to remove calculi, we have to contend against unorganized bodies, which, though contained in living parts, do not obey the laws of the living principle, it may be fairly concluded, that, unless surgical aid be resorted to, it is in a great measure from chemical principles that our views of treatment must be derived.

Considerations on the nature of urine.

The general principles upon which the chemical treatment of the disorder rests, being necessarily connected with peculiarities in the secretion of urine, it will be indispensable to enter into a few explanations on this subject.

Among the great variety of saline substances which human urine contains, there

are some, the consideration of which is more immediately connected with our present subject, from the circumstance of their being comparatively little soluble, and therefore more liable than others to separate in a concrete form. These are the phosphat of lime, the phosphat of magnesia, and the lithic acid. The two earthy salts are held in solution chiefly by the phosphoric acid, but partly also, as Professor BERZELIUS has shown, by the lactic acid.* It has long been observed that healthy urine, when first voided, is slightly acid, as appears from its reddening vegetable blue colours. This effect is owing partly to an excess of the phosphoric acid, and partly to the lactic and lithic acids, portions of the two last acids remaining uncombined in the urine

* The treatise of BERZELIUS on Animal Chemistry, which appears from the fragments published in the French and English language, to be far more comprehensive and more replete with original observation than any other work on the subject, has unfortunately not yet been translated into the English language. A very interesting abstract, however, of his observations on the animal fluids, was published by BERZELIUS himself in the third volume of the Medico-Chirurgical Transactions,

on account of their possessing the weakest attractions for saline bases.

On standing a day or two, or sometimes merely on cooling, portions of lithic acid and of phosphat of lime spontaneously subside from the urine; but if it be kept a sufficient length of time, a process of decomposition takes place, and a quantity of ammonia is generated, which unites with and neutralizes any portion of uncombined acid contained in the urine, and thereby occasions a precipitation of the earthy and less soluble salts, especially the phosphat of lime, and the ammoniaco-magnesian phosphat.*

* This accounts for the fact already noticed, that when calculous matter is formed around any foreign substance accidentally introduced into the bladder, and obstructing or restraining the egress of the urine, the deposit always consists, at least principally, of the phosphats, as the urine, under these circumstances, undergoes an incipient process of decomposition. And in the same manner we may readily explain the very frequent occurrence of a crust of the phosphats forming on a lithic or mulberry nucleus.

It follows from these circumstances, that if any alkali (a few drops of ammonia, for instance) be added to recent urine, a white cloud appears, and a sediment, consisting of phosphat of lime, with some ammoniaco-magnesian phosphat, subsides, in the proportion of about two grains of the precipitate from four ounces of urine. Lime-water produces a precipitate of a similar kind, which is still more copious; for the lime, in combining with the excess of phosphoric, and perhaps also of lactic acid, not only precipitates the phosphat of lime which these acids held in solution; but it decomposes the other phosphats, thus generating an additional quantity of the phosphat of lime, which is also deposited. The alkalies precipitate the earthy phosphats.

If, on the contrary, a small quantity of any acid, either the phosphoric, the muriatic, or indeed even common vinegar, be added to recent healthy urine, and the mixture be allowed to stand for one or two days, small reddish crystalline particles of lithic acid will be gradually deposited on the inner surface of the vessel. The acids precipitate lithic acid

Summary view of the medical treatment in cases of lithic, or of earthy calculi.

It is on these two general facts that our principles of chemical treatment ultimately rest. Whenever the lithic secretion predominates, the alkalies are the appropriate remedies; and the acids, particularly the muriatic, are the agents to be resorted to, when the calcareous or magnesian salts prevail in the deposit.

Can acids or alkalies reach the urinary passages?

Before, however, we can give our full approbation to these general principles, various questions present themselves. In the first place, it will naturally be asked, whether acids or alkalies can actually be conveyed to the urinary passages through the medium of the circulation? With regard to the alkalies, the fact has long been decided in the affirmative, upon the most respectable authorities. Indeed, most practitioners of the present age must have had opportunities of observing, that a long course of alkaline medicines will often not only deprive the urine of its acid properties, but will render it decidedly alkaline, and even (as was pointed out by the Bishop of LANDAFF) capable of dissolving lithic

acid.* A case, illustrative of this, was a few years ago published by Dr. BOSTOCK; † and Mr. BRANDE has shown, that this alkalescence in the urine is produced within a few minutes after taking the alkalies, whether they be in the caustic or sub-carbonated state. ‡

Doubts as to the acids in this respect.

With regard to the acids, the question is not so easily resolved. For as the urine is naturally acid, and especially contains portions of both the muriatic and sulphuric acids, which are those commonly used as medicines, any small increase of either of these acids in the urine, in consequence of their being taken into the stomach, cannot be so readily ascertained. It is however stated by some chemists, and in particular by Mr. BRANDE, that acids taken into the stomach are actually capable of being conveyed into the bladder §; and this he has more especially endeavoured to ascertain by experiment with regard to the carbonic acid. || Un-

* WHYTT's Works, 4to. p. 446.

† Medico-chir. Trans. vol. v. p. 81.

‡ Phil. Trans. 1810, p. 143.

§ Phil. Trans. 1808, p. 242.

|| Phil. Trans. 1810, p. 146.

fortunately, however, although alkalies do certainly, and acids may possibly, reach the urinary passages, yet experience has shown, that the quantity of either, thus conveyed through the circulation, is so small, that very little, if any impression can be made on large pre-existing calculi, with whatever freedom or perseverance these medicines may be used. But there is abundant evidence to prove that we are able in many instances to produce an effect sufficient to check the prevailing diathesis, and even sometimes to bring on a calculous deposit depending upon an opposite state of the system; a change which I have myself repeatedly witnessed.*

Illustrative cases. * Of the various well authenticated instances of this kind which have come to my knowledge, upon the authority of others, I shall mention the two following: A middle aged clergyman of literary habits, of remarkable firmness of mind and accuracy of observation, and whose son was a physician, was seized with symptoms of calculi in the kidneys, attended with frequent acute paroxyms, generally terminating in the discharge of calculous fragments of lithic acid. He continued about twenty years in a state of almost constant and increasing suffering, taking a variety of medicines, and especially lime-water and soap, with great perseverance,

But even supposing that not an atom of either acid or alkali should be capable of

Another mode of viewing the effects of chemical agents.

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and with occasional benefit, but without any permanent advantage. At last, on the suggestion of his medical friends, he began to make use of an alkaline lixivium in daily and considerable doses. The benefit derived from this medicine was so great and manifest, that he persevered in it for ten years, after which he died at a very advanced age of a complication of infirmities, the calculous disorder however remaining greatly mitigated during the last years of his life. I have before me a daily journal of this interesting case, kept with remarkable care and accuracy, by the patient himself, during a period of 30 years; and which, towards the close of his life, he concludes by the following important observation:—"Having thus continued a plain relation of facts during 10 years' use of the lixivium, to this day, I shall make no other deduction, than to assure others, from my own experience, that this medicine may be persevered in with safety when taken regularly; and in all common cases, with the most hopeful prospect of success."

I have also before me the numerous specimens of calculi which this interesting sufferer passed at different times, and I observe that those which he voided whilst taking the alkaline lixivium, though still lithic, were in some instances evidently covered with a whitish crust, containing small portions of phosphat of lime; and some of these calculi had their angles rounded, and their edges blunted in a manner which could hardly be explained, except from the long continued effect of the alkaline medicine. After death, calculi of a considerable size were found both in the kidneys and bladder, and some

reaching the urinary passages, still it is not unreasonable to expect that these remedies may respectively produce the desired changes during the first stages of assimi-

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of them had their surface modified by the alkaline medicines, like the fragments I have just described, and the external layers were loosened in their texture, so as to render it evident that scales had been detached from them by a kind of process of exfoliation.

The other case occurred, not long since, to Mr. ASTLEY COOPER, in consultation with Dr. BAILLIE and Mr. FREEMAN, surgeon in Spring-gardens, the latter of whom, conjointly with Mr. COOPER and the patient himself, obliged me with the following particulars; and although I could easily relate several instances of a similar kind, under my own observation, I prefer selecting this as likely to carry particular weight. A gentleman from Birmingham came to London for advice, labouring under a severe irritation in his bladder and urethra, attended with frequent micturition, and a copious discharge of white sand, mixed with shining crystalline particles, the quantity of which amounted to 8 or 10 grains every time he voided his urine. Muriatic acid was prescribed, by the medical gentlemen above-mentioned, in the dose of 5 grains of the concentrated acid, properly diluted, three or four times a day; and in a few days the symptoms were relieved, and the urine began to deposit lithic acid, in the form of a red sediment. This treatment was continued for about two months, during which there was no calculous discharge, except now and then a little lithic acid; and at this moment the patient's health is considerably improved, and his urine remains free from calculous deposition.

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lation; in one case by neutralizing any morbid excess of acid in the *primæ viæ*; and in the other, by checking a tendency to alkalescence, or otherwise disturbing those affinities, which, in the subsequent processes of assimilation and secretion, give rise to calculous affections.

With regard to the mode of administering either acid or alkaline medicines, it does not present any practical difficulties. Very few stomachs are liable to be materially disturbed by moderate doses of either the mineral acids or carbonated alkalies. Even those persons who are liable to what is commonly called acidity of the stomach, can often take muriatic acid, properly diluted,

Mode of administering acid or alkaline remedies.

Acids.

The case of the celebrated HORACE WALPOLE, published by himself in the Philos. Trans. for 1750, vol. lxxxi., affords evidence of an analogous kind. He insisted strongly upon the benefit he had experienced from the internal use of soap and lime-water; and when he died in 1757, Sir JOHN PRINGLE, who published an account of the state in which his body was found, stated that three small rounded stones were found in the bladder; and all the circumstances of the case concurred to show, that some impression had been made on the calculi by the long continued use of those remedies.

without any inconvenience; and I have even known instances in which stomachs, so disordered, have appeared benefited by the use of that remedy. There is indeed this difference between the mineral and the vegetable acids, that the latter may possibly undergo decomposition during the process of assimilation, and form new combinations, the tendency of which may be prejudicial; while the mineral acids, though possessing strong powers of combination, are not themselves capable of being decomposed in the digestive organs. From 5 to 25 drops of the strong muriatic acid, taken two or three times a day sufficiently diluted with water, are the doses in which I have usually administered that medicine.

Alkalies. As to the alkalies, the form in which they are usually and most conveniently taken, is that of the well known artificial beverage commonly called soda-water, in which the carbonated alkali, being supersaturated with carbonic acid, by great mechanical pressure, loses its caustic and disagreeable taste; so that a tumbler-glass full of this water, containing from half a dram to

one dram of the carbonated alkali, makes a pleasant beverage, in which the offensive effects of caustic alkali are entirely obviated. If however this medicinal drink cannot be procured, from 5 to 20 or 30 grains of carbonat of soda, whether in the state of subcarbonat, or in that of neutral crystallized carbonat, may be taken two or three times a day, dissolved in a little water, a remedy which generally produces relief, without occasioning any obvious inconvenience.

Question on the agency of alkaline carbonats in calculous disorders.

But a question naturally arises, respecting the use of alkali in the state of carbonat: it may be asked, how is it possible that alkali, though neutralized or even supersaturated by carbonic acid, should still have the power of conveying to the urine alkaline properties? This however is undoubtedly the fact; and we know, upon the authority of Sir GILBERT BLANE *, that even the presence of citric acid, combined with the alkali in the form of the common

* See a paper 'On the Effects of large Doses of mild vegetable Alkali,' &c. in the Medical and Chirurgical Transactions, vol. iii. page 339.

saline draught, does not prevent the latter from depriving the urine of its acid properties.

In the case of the carbonated alkalies, this apparent difficulty can be easily explained; for it is obvious that the gaseous acid possessing but a very weak attraction for the alkaline bases, the alkali of the carbonat may have the power of combining with, and neutralizing in the stomach any other uncombined acid, by which the secretion of lithic matter might be promoted; whilst the carbonic acid, thus disengaged, is expelled from the stomach in its gaseous state.

With regard to the citric acid, the case is somewhat different, since after yielding its alkali, the acid remains in the stomach, where it might be supposed to produce that diathesis which is favourable to the developement of the lithic deposit. But it may be supposed, (as Sir GILBERT BLANE suggests) that the organs of assimilation or secretion have the power of decomposing

the salt in question, and of retaining only its alkaline base.

The principal use of carbonic acid in calculous disorders, is, no doubt, that of being a convenient vehicle of alkaline remedies. But it has been asserted, by several medical and chemical observers of considerable weight, that carbonic acid is of itself capable of penetrating into the circulating fluids, and actually reaching the bladder in its uncombined state, so as to act as a solvent upon the calculi contained in it. PRIESTLEY inclined to this opinion *, and Dr. PERCIVAL considered the fact as perfectly established. † Dr. DOBSON, in his 'Commentary on fixed Air,' Dr. SAUNDERS, and Dr. FALCONER, have all entertained similar opinions. On the agency of carbonic acid.

These notions, however, respecting the solvent property of carbonic acid, and its

* Experiments and Observations on Air, vol. ii. page 216.

† PERCIVAL's Works, iv. 119.

power of reaching the bladder, could only be conjectural at the period when they were published. For as the nature of urinary calculi was then almost unknown, any reasoning on the powers of solvents must have been extremely vague and hypothetical; and the evidence upon which these writers grounded their belief of carbonic acid being conveyed to the bladder, was obviously very imperfect. More lately, however, Mr. Brande, following up some inferences derived from Dr. Wollaston's discoveries on the nature of urinary calculi, administered water impregnated with carbonic acid to a patient subject to void with his urine a white sand composed of the phosphats; and he observed that the deposition ceased during the use of that medicine, and that it began again when the acidulated drink was left off. Mr. Brande also mentions some experiments which led him to conclude, that the urine of persons who are drinking waters impregnated with carbonic acid, contains a superabundant quantity of this acid, which may be separated from the urine, in the gaseous state,

by means of the air-pump.* But as he does not relate in detail his mode of operating, and as I know from my own trials, which have yielded somewhat different results, the great difficulty of avoiding all sources of error in ascertaining this point, I own that I still consider the fact of the passage of carbonic acid gas from the stomach into the urine, as very improbable.† Whether urine contains uncombined carbonic acid?

* Philos. Trans. 1810, page 146.

† The experiments which I tried on this subject are as follows: — Some urine which had been voided *before* breakfast, and had been allowed to stand for about an hour, was warmed again, in a water-bath, to about 120°, and was then exposed to the vacuum of an air-pump, by means of an apparatus adapted to convey any elastic matter arising from it through a small quantity of lime-water. The urine soon began to boil, and a current of gaseous matter passed through the lime-water, which in a few minutes became quite milky, and deposited a calcareous precipitate, which effervesced with acids.

Suspecting that the previous cooling of the urine, in the above experiment, and its being subsequently warmed, might have occasioned the formation and evolution of carbonic acid, I repeated the experiment, with this difference, that the urine was exposed to the process of exhaustion at the moment it was voided, having only its natural degree of warmth. There was not, in this case, the smallest quantity of carbonic acid gas evolved, though the experiment was conducted (except as to the

At all events, however, it is not difficult to conceive that the introduction of carbonic acid into the stomach, may, like that of the mineral acids, of alkalies, and of various

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circumstance just mentioned) exactly in the same mode as the preceding,

In another experiment made with urine voided about an hour *after* breakfast, I could not detect the smallest vestige of carbonic acid. On the same morning I swallowed at one draught nearly a pint of Paul's highly carbonated soda-water; and having examined, in the mode above described, the urine made about an hour afterwards, it did not appear to contain a single atom of carbonic acid gas.

I now became pretty confident of the truth of my conjecture respecting the cause of the evolution of carbonic acid; but on repeating the experiment one morning after breakfast, in the presence of Dr. WOLLASTON, the urine, to my great surprise, gave out carbonic acid, though it had neither been suffered to cool, nor undergone any subsequent elevation of temperature.

In several trials which I have since made at different periods of the day, carbonic acid gas has uniformly been given out; and the general inference to which these discordant results seem to lead is, that the evolution of carbonic acid gas from the urine, whether arising from the presence of uncombined carbonic acid, or from some decomposition of the animal matter contained in that fluid, depends upon certain states of the body at the moment the urine is secreted, rather than upon the introduction of the gaseous acid through the digestive organs.

other medicinal agents, produce such stimulating effects on the digestive organs, as to counteract, independently of any direct chemical agency, the particular action which gives rise to urinary concretions.

On the use and abuse of magnesia.

The practice of substituting the use of magnesia for that of alkaline medicines, in cases of lithic calculus (which was suggested by Sir EVERARD HOME and Mr. HATCHETT, and communicated to the public by Mr. BRANDE †), is an useful addition to the medical treatment of calculous disorders. Magnesia, being less offensive to the stomach, and yet capable of removing acidity from the digestive organs, (an inconvenience generally accompanying the calculous diathesis) it is often found advantageous to use it in long protracted cases, rather than caustic or sub-carbonated alkali, the constant use of which would ultimately injure the stomach. Yet such is the tendency which the public has to over-rate the utility of a new practice, or to take a mistaken

* Phil. Trans. 1810, p. 136.

view of its proper application, that there is every reason to believe that the use of magnesia has, of late years, become a frequent source of evil in calculous disorders.

In the first place, it cannot be doubted but that whenever it is desirable to convey to the urine alkaline properties, the mineral alkalies will answer this purpose more quickly and readily than magnesia, a much less soluble substance, the powers of which probably depend partly upon its aperient effect, and partly upon the absorption of redundant acid. But there is another and more important objection to the indiscriminate use of magnesia, which is, that this earth being the base of one of the most common species of calculi, the ammoniaco-magnesian phosphat, there is nearly an even chance, when magnesia is prescribed without any previous knowledge of the nature of the calculus, that it will prove injurious, not only by affording the principal element of that calculus, but also by neutralizing in the *primæ viæ* any portions of uncombined acid, by means of which the calculous matter might have been held in solution.

That this may actually happen, I have myself, within the last few years, repeatedly witnessed; that is to say, I have met with patients who had been for months, or even for years, in the habit of taking daily doses of magnesia, either by the advice of their medical attendants, or merely in compliance with the popular practice, for the removal of calculi or gravel, which proved, on examination, to be of the magnesian or fusible kind. The complaint had, by this means, become more and more confirmed; and the patients mistaking the aperient and neutralizing properties of the alkaline earth, for its supposed solvent powers, had continued this baneful practice, till the examination of the sand deposited by the urine, or of some fragment of the calculus, had made them aware of their error.

I have already had occasion to mention, in a preceding chapter, another kind of inconvenience sometimes arising from the obstinate and injudicious use of magnesia, which was lately pointed out by Mr. Edward Brande*; I mean the accumulation and

* See Journal of the Royal Institution, vol. i. p. 297.

consolidation of large masses of magnesia, which from accidental causes, are sometimes detained in the intestines, in which they have been known to produce distressing and even fatal effects.*

Alkaline remedies allay irritation.

I should not omit to mention, while upon the subject of alkaline medicines, that the use of alkalies in calculous disorders is evidently not confined to their chemical agency, since they are uniformly found to allay the irritation of the bladder, and promote the flow of urine, even when, from the chemical composition of the concretions, alkaline remedies can be of no use as solvents. This effect, of which no plausible explanation has I believe been yet given, is observed whether the alkali be used in its

* An instance of the same kind was noticed several years ago by Dr. HENRY, and published by Dr. MONRO, in his Morbid Anatomy of the Gullet, &c., page 34. Dr. HENRY, to whom the world is indebted for having, conjointly with his father, introduced valuable improvements in the preparation and purification of magnesia, has also taken every opportunity of warning the public against the risk of using it in an excessive or indiscriminate manner.

caustic or in its mild state; and it appears to be also in some degree produced by magnesia. Practitioners, therefore, may sometimes be induced to have recourse to these remedies as palliatives, when the irritation is extremely urgent, even though aware, from their knowledge of the calculus, that alkalies cannot produce any essential or permanent benefit. In cases of this kind, the addition of opium to the alkali is a most powerful auxiliary, the utility of which has been strongly pointed out by Sir G. BLANE, in the paper to which I have already had occasion to refer.*

It is also necessary to observe that the presence of calculi in the urinary passages, or even the mere tendency to secrete calculous matter, is always accompanied, more or less, with a secretion of ropy mucus from the coats of the bladder, which assists greatly the formation of concretions. This has appeared to me to be more especially the case when the calculous deposition

Morbid mucous secretion

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* Medical and Chirurgical Transactions, vol. iii.

is of the chalky or fusible kind. At first this mucous secretion is probably only a consequence, but it soon becomes a concurrent cause of urinary concretions. The use of alkalies unfortunately tends to increase this inconvenience, by precipitating from the urine the mucus which is held in solution by the redundant phosphoric acid. The muriatic acid on the contrary, assisted by plentiful dilution, has sometimes, in a remarkable degree, the effect of checking the mucous secretion. But it is also liable to increase the irritation of the bladder, in which case it may become necessary to lay it aside altogether. These circumstances all concur to show, that in attempting to relieve calculous disorders by medicines, the chemical views of treatment, however plausible, must occasionally yield to collateral considerations, which require our more immediate attention.

This mucus, small quantities of which are secreted at all times by the bladder, but which assumes, when the membrane is inflamed, a remarkably ropy and glutinous character, is no doubt one of the ingre-

dients of the animal matter or cement which binds together the layers or successive depositions of urinary calculi. This cement however appears to be of a compound nature and to vary in the different species of calculi. * Dr. HENRY considers it as consisting chiefly of albumen †; and other chemists, amongst whom is Mr. BRANDE ‡, have detected considerable quantities of urea in urinary calculi, a circumstance which is often indicated by the peculiar smell which they exhale when urged by the blow-pipe.

Difficulty in the treatment from the alternations of calculous deposits.

I have more than once alluded to the difficulty which may occur, in the treatment of calculi, from the changes which take place, either spontaneously or from the use of particular medicines, in the nature of the calculous secretion. § This is

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* FOURCROY, 'Système des Conn. Chim.' x. p. 233.

† 'Dissertatio de Acido Urico,' p. 13.

‡ Philos. Trans. 1808, p. 229.

§ It has, in a few instances, happened to me to meet with both the fusible and the lithic sand mixed together in the urine; this I ascribed to a change in the secretion

indeed the chief difficulty in practice, yet by a due attention to the state of the urine, and especially of the sediment which it deposits, the problem may in most instances be resolved, especially as patients labouring under calculus are usually subject to pass gravel or small fragments, which are quite sufficient to enable the practitioner to ascertain the nature of the calculous secretion which prevails at the time, so that he may adapt his treatment to the removal of that diathesis. As to the different modes of examining the calculous matter, they have been so fully described in the preceding pages, that it would be quite superfluous to repeat them here. But I have been favoured by Dr. Prout with an observation which I believe to be new, and which may assist in forming a conjecture on the nature of the calculus from the examination of the urine, when no better

going forward at that moment. But it not unfrequently happens that one of these secretions stops, and is immediately succeeded by the other, especially when medicines are used for the purpose of removing the prevailing diathesis.

evidence can be obtained. Dr. Prout's remark is, that, when the urine contains urea in abundance, the phosphats generally prevail; while if the urine abounds in colouring and extractive matter, we may conclude that the lithic acid is the prevailing secretion. According to Dr. Prout's observation likewise, although urea and lithic acid do not co-exist in urine in large quantities, when the phosphats are deficient; yet sometimes the three substances, urea, lithic acid, and the phosphats, are found to exist together in abundance.

A method was long ago proposed by Fourcroy, to ascertain the nature of a calculus in the bladder, which deserves to be noticed. It consisted in successively introducing, by the urethra, into the bladder weak solutions of muriatic acid, and of alkali, and, after leaving them in the bladder for some time, examining the state of these solutions when voided with the urine. If, on adding to the mixed alkaline solution and urine, some dilute muriatic acid, a precipitate take place, it may be inferred that the calculus in the bladder consists

Method proposed by Fourcroy to ascertain the nature of a calculus in the bladder.

chiefly of lithic matter. If, on the other hand, when muriatic acid has been injected into the bladder, lime or magnesia is discovered in the urine by their respective re-agents, we may conclude that the calculus is composed of the phosphats. This method however, though by no means impracticable, would probably be found too difficult for common use; and I have not heard that it has ever been tried in this country, or even in France, since FOURCROY's publication.

Treatment of the mulberry and cystic-oxyd calculi.

The formation of oxalat of lime, of cystic oxyd, and of the two new calculi, which I have described, presents varieties of disease, the appropriate treatment of which is not obvious. For while the mulberry calculus is incapable of being acted upon by any quantity of acid, which can be introduced into the system, both the cystic oxyd and the xanthic calculus are soluble in either acids or alkalies; and the fibrinous concretion is hardly acted upon by any chemical re-agents. There is another difficulty respecting these four species of calculi, which is, that no vestiges of them being

discoverable in the urine, it is not easy to perceive to what kind of alteration in that secretion it is most desirable to direct the treatment, with a view to correct the calculous diathesis in question.

With regard to the oxalat of lime, the acid of sugar, as Dr. WOLLASTON observes *, being known to abound naturally in a species of oxalis, it is probable that it may be contained also in other vegetables or fruits; and therefore it may be assumed that the secretion in question would be modified by avoiding such vegetable aliments as may be suspected of yielding that acid. The alkalies may be used with advantage in this, as in the other species of calculi, to allay irritation; and they may also possibly be beneficial by combining with the oxalic acid in the *primæ viæ*, and preventing those displays of affinities which cause it to unite with the lime. Yet a still more beneficial effect is likely to be obtained from the use of the mineral acids, which

* Philos. Trans. 1797, page 14. (private copies).

have the power of dissolving the oxalat of lime in its nascent state, and may therefore, if it do not prevent its formation, at least serve to assist its passage and ultimate expulsion from the system in a state of solution.

As to the remaining species [redacted]alculi, and especially the cystic oxyd, and the xanthic calculus, since these are soluble both in acids and alkalies, the use of either the one or the other class of re-agents, must be determined by collateral circumstances, and by future trials. But in the calculus consisting of fibrine, a system of mild and plentiful dilution, and a constant endeavour to soothe, in the urinary passages, that irritation which is the probable cause of its formation, are the only objects in practice from which, till the subject has been farther investigated, we can reasonably expect any benefit.

Effect of purgatives in calculous disorders.

There is a circumstance in the history of calculous disorders, which, though in a great degree unexplained, well deserves to be noticed. I mean the effect which a brisk

purgative often has, not only in promoting the discharge of calculous matter or gravel, when it is small enough to pass through the natural passages; but also in giving a temporary check to its formation. This is most striking in the case of gout, in which the lithic diathesis is so apt to prevail, and in which the symptoms are often altogether removed by the operation of a brisk cathartic; and Dr. PROUT informs me that he has repeatedly seen, especially in children, a calculous deposition cease to appear in the urine, from the administration of purgative medicines.

Of turpentine and opium.

Another auxiliary remedy, in the treatment of calculus, which has been pointed out to me by Dr. HENRY of Manchester, and may perhaps prove valuable, is the use of turpentine combined with opium. Dr. HENRY informs me that he has seen several instances in which a quack medicine, apparently composed of these ingredients, has produced a plentiful discharge of lithic acid; and from the known stimulating powers of the oil of turpentine on the urinary organs, it is not improbable that it would produce

analogous effects in the other species of calculous disorders.

Considerations on diet in calculous affections.

I have already occasionally alluded to the importance of paying a due attention to diet, with a view to check the tendency to form urinary calculi. This is unquestionably an important point in the treatment, although, as was observed before, peculiarities of diet alone are by no means sufficient to account for the formation of calculi. An acescent state of the digestive organs being an almost constant and leading feature of the calculous, as well as of the gouty diathesis, it is obviously desirable to refrain from all excess in diet, and to avoid all articles of food or drink, which are known to increase or produce acidity in the stomach. This acescent tendency, however, does not by any means exclusively belong to this species of calculus, nor does it appear to be essential to the disease: for I have repeatedly observed it in persons subject to the calculus consisting of the earthy phosphats; and, in a few instances, I have seen this symptom totally wanting, even in lithic or gouty patients. I am therefore inclined to

consider this great liability to acidity in calculous complaints, rather in the light of a dyspeptic affection, arising from irritation in the urinary organs, with which the stomach is known strongly to sympathize, than as the original cause of calculous disorders.

It may be worth while to observe, whilst upon the subject of diet, that it would probably not be found advisable to restrict calculous patients to the use of animal food alone, with a view to prevent acidity in the stomach; for it appears from some direct experiments upon certain kinds of animals *, that when fed exclusively upon animal food, they secrete more lithic acid. It is natural to infer, therefore, that it might be found detrimental to restrain patients affected with this kind of calculus from taking a due proportion of vegetable nourishment.

Upon the whole, it appears exceedingly probable, on reviewing all the phenomena of calculous disorders, and in particular on

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* See a paper of Dr. Wollaston, in Philos. Trans. for 1810, page 136.

recollecting the benefit which is frequently experienced in this disease from the use of cathartics, and also from that of various tonics, that these affections most frequently originate from a deranged state of the digestive organs; and that such remedies as may fail in being of use as chemical agents, may still often prove beneficial by their tonic or stimulating effects.

Influence of the cutaneous functions.

The functions of the skin have probably a much greater connexion with the formation of calculi than has been commonly imagined. I have already noticed the circumstance of calculous affections being extremely rare in warm climates. Even in our own latitudes, it has been ascertained that while the body is exposed to profuse sweating, the urine discharged has its proportion of lithic acid considerably diminished; and that the urine which is first discharged in the morning, however highly concocted, contains less acid than that which is secreted during the day.*

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* WILSON, on the Cause of Urinary Gravel, 1792; and HENRY, Dissert. de Acido Urico, 1807. I have not been able to meet with Dr. WILSON's work in the

Of injections into the bladder.

I have hitherto kept out of view the most direct, and, as it was at one time supposed, the most promising method of applying chemical solvents to the removal of calculi from the bladder; I mean the frequent and periodical injections of alkaline solutions by the urethra, with a view gradually to dissolve the stone contained in the bladder, or at least to reduce it, and to divide it into fragments sufficiently small to admit of being discharged through the natural passage.

Some encouraging trials of this kind are related by FOURCROY in his System of Chemistry, and a few similar attempts have also been made in this country. But whether from the extreme degree of patience and perseverance they require, or from the difficulty and inconvenience attending the introduction of a foreign, and always more

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libraries to which I have had access; but from some extracts I have seen, I have reason to think that it contains important physiological remarks, though written before the late discoveries on the chemical composition of urinary calculi.

or less irritating substance into the bladder, these trials have not led to any decisive results, and have, for some years, been almost entirely abandoned. As, however, I am by no means satisfied that the subject has yet been sufficiently investigated to justify its being entirely laid aside, I shall offer a few remarks which may be of use to future enquirers.

When sufficient evidence on the nature of the calculus has been procured, either by the evacuation of some gravel, or by the indications obtained from a dilute alkaline or acid solution, injected into the bladder, and afterwards examined when discharged, the appropriate solvent, duly diluted, may be now introduced. This operation, however, requires to be repeated very frequently before any material impression can be made upon the calculus, especially as in order that the bladder may be enabled to bear these injections, they must be in a state of very great dilution. In general the alkalies excite less irritation than the acids; but both may be used and retained for some time in the bladder with little difficulty,

when so much diluted as that they might be swallowed without inconvenience, a state in which they can still act on the concretions. In an aggravated case of fusible calculus, in which (as appeared afterwards on dissection) the bladder was extensively diseased *, I prescribed injections, which contained only at first two drops of acid in four ounces of water; and the acid was gradually increased to twenty-three drops, without producing any inconvenience, though the solution was often retained in the bladder as long as an hour. Half a dram of pure opium was dissolved in the same injection, and the anodyne solution alone was also sometimes injected with advantage.

Patients, in trials of this kind, in order to be reconciled to the great perseverance which they require, should be taught to use the syringe themselves; and it has even

* This is the instance which has already been repeatedly alluded to, in reference to Plate IX., to which a short history of the case is annexed.

been recommended that the catheter or syringe should habitually remain in the urethra, this plan being likely to occasion less irritation than the frequent introduction of the instrument is known to produce.

Another precaution required is, that the patient should empty his bladder as much as possible, just before the injection, both in order to take off any irritation arising from distension, and to relax the sphincter of the bladder; and also with a view to prevent the alkali (if the injection be alkaline) from uniting with the phosphoric acid of the urine, which would neutralize its effects; or from separating and precipitating from the urine a thick ropy mucus, which is kept in solution by the phosphoric acid.

Conclusion. These are the most important remarks which occur to me respecting the medical treatment of urinary calculi. I had originally intended to detail some cases which had fallen under my own observation, in which these views, respecting the cure of calculous disorders, appeared to lead to favourable results. But as this addition

would have considerably lengthened this Essay, and would scarcely have been compatible with the present plan of the work, I have contented myself with occasionally alluding to the results, and briefly noticing some of the cases in the course of the work. I may perhaps, however, take some future opportunity of entering more fully, and with a greater stock of facts, upon the practical part of the subject.

THE END.

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PLATE I.

Represents a diseased kidney, from the museum of Guy's Hospital, in which the pelvis, P, is seen much enlarged, and distended by a number of calculi closely pressed against each other. Other calculi are seen in the enlarged infundibula, A, B, C, which have been laid open, to bring into view their interior, and to show how these cavities may be gradually dilated by the growth of the stones, the substance of the kidney being proportionally absorbed.

The patient from whom this kidney was taken died under my care at Guy's Hospital, with symptoms of hydrothorax; and he never complained to me of any affection in his kidney or other urinary passages.

PLATE II.

Represents a diseased kidney, from a preparation in Mr. Abernethy's collection. The calculus which it contains appears in the form of a single mass, filling and distending the enlarged capacity of the pelvis A, the parietes of which have been almost entirely absorbed. From this mass there branch out other smaller masses which fill the enlarged infundibula D, C, B, &c., in the same mode as the pelvis, the whole kidney being thus almost entirely absorbed, and replaced by the concretion.

PLATE III.

Represents the bladder of an adult female, with a calculus in it. This preparation (which belongs to Mr. ASTLEY COOPER) shows the contraction of the bladder round the calculus which fills its capacity almost entirely, and the thickening of its coats and enlargement of the ureters. It shows also the thickening and spongy state of the mucous membrane of the bladder.

This preparation, as well as those delineated in Plates IV. and IX., may be seen in the Museum of St. Thomas's Hospital.

PLATE IV.

This Plate was taken from another preparation of Mr. ASTLEY COOPER. It illustrates well a singular variety of calculous disease. Here several calculi, C, D, E, are seen enveloped and fixed in distinct cysts or recesses, formed in the substance of the bladder; and these calculi, from pressing against others lodged in contiguous cysts, receive those regular faces and angles which are often observed in such concretions. Other empty cysts are seen, A, B, &c., from which other calculi have apparently dropped off.

This peculiarity in the formation of calculi accounts for the occasional disappearance of the symptoms of the stone, and the difficulty of discovering it by the sound, in cases in which it has been found in the bladder after death.

PLATE V.

Represents a calculus, C, in the urethra, U S, detained on its passage, by a stricture in S. The great thickening of the urethra, and the dilatation of its canal, behind the stricture, are strikingly illustrated in this preparation, which is in the collection of Mr. Abernethy at St. Bartholomew's Hospital.

PLATE VI.

Represents varieties of lithic calculi.

Fig. 1. Shows the oval shape and finely tuberculated, though smooth, surface of the calculus; and a small portion has been cut off to show its laminated structure.

Fig. 2. Shows a fragment of a very large lithic calculus, with a distinct nucleus, which is darker and more compact than the rest. A dark vein is seen a little above the nucleus, which is a thin layer of oxalat of lime or mulberry calculus. The external surface of this calculus (which is in the collection of Guy's Hospital) is remarkably smooth and polished. This mass is much disposed to break in fragments, in the direction of its laminæ.

Fig. 3. & 4. Show the internal concentric layers of lithic calculi. The external surface of the one, fig. 3, is tuberculated, like that of fig. 1; but the surface of the other, fig. 4, is covered with a white coat of the chalky or fusible calculus, as may be seen from the small portion of the surface which is brought into view.

PLATE VII.

Fig. 1. A fusible calculus, with the neck or pendunclc, which is often observed in this species.

Fig. 2. The same species of calculus broken, and exhibiting its usual uneven ragged fracture. It was taken from the bladder represented in Plate IX.

Fig. 3. A mulberry calculus, with a lithic nucleus in *n*; its tuberculated structure in *m*, and its fusible external covering in *f*.

Fig. 4. The external appearance of a well characterized mulberry calculus.

Fig. 5. A section of the same species of calculus.

PLATE VIII.

Fig. 1. A cystic calculus seen externally.

Fig. 2. A section of the same calculus.

Fig. 3. A cystic calculus taken from the kidney.

Fig. 4. A calculus with three flattened sides, a form which calculi often assume from pressure against each other.

Fig. 5. Crystallized triple calculus, or ammoniaco-magnesian phosphat.

Fig. 6. The hemp-seed calculus, or smooth oxalat of lime.

Fig. 7. A well characterized fragment of pure bone-earth calculus; in which the radiating, as well as concentric fibres, are distinctly expressed.

Fig. 8. A calculus exhibiting nearly all the species, in concentric layers, viz. lithic in the centre, L; bone-earth next, in P; mulberry next, in m; and fusible last, in f.

PLATE IX.

Fig. 1. A diseased bladder and prostate (case of Wild).* Its coats are thickened. The mucous membrane is destroyed by ulceration, so that the muscular fibres of the bladder may be seen from the interior. The ulcerated projections are lined with calculous incrustations forming an extremely rough surface. This bladder contained the calculus represented in Plate VII. fig 2.

The prostate gland O P is enlarged, as also the urethra, which is seen passing between its lobes. In the right lobe is seen a cyst which has undergone a process of inflammation. It contained a number of small reddish-brown calculi, the colour and ·ous sizes of which are expressed in C, D, ·g. 2. The other lobe, though also enlarged, was in other respects unchanged in its structure, and presented no cavity.

Fig. 2. Represents a section of part of another diseased prostate, and shows numerous calculi contained in the enlarged cells of the gland. This is by far the most common form of the disease.

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* ·nan, who was at different periods a patient in Guy's ·ospital, and was the subject of some trials, alluded to in this work, on the effects of injections into the bladder, laboured under a remarkable complication of calculous disorders. He had a most extensive disease in his bladder, from which a large fusible calculus was extracted after death; his prostate gland contained upwards of a hundred calculi, and was otherwise much diseased; his kidneys were found to have had their glandular substance partly absorbed, whilst the infundibula and pelvis had their capacity much increased, and the ureters were also enlarged and thickened: yet this unfortunate sufferer lived many years in this state, before death terminated his existence.

PLATE X.

Fig. 1. A common glass blow-pipe.

Fig. 2. & 3. Small platina tongs.

4. A tray, containing test-bottles and tubes.

6. Test-bottle, with a glass tube attached to the stopper, for the purpose of taking out one drop of the solution.

7. & 8. A support, to hold watch-glasses, or cups, over the lamp, with the hand.

9. A stand, to support watch-glasses, or cups, over a lamp.

10. An appropriate lamp.

11. Blow-pipe, made of brass, and of a convenient construction.

12. A platina *tip* fitting the blow-pipe in *d*.

13. A spirit lamp, with a glass cup, *c*, to cover it when not used.

14. & 15. Watch-glass, and glass capsule.

16. A bottle, with a tube through its cork, to obtain water drop by drop.

